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LOCOMOTIVE DESIGN.—THE WORKING STRENGTH OF MATERIALS.

By F. J. Cole, Mechanical Engineer, Rogers Locomotive Works.

Main or Connecting Rods.

The force which the main connecting rod transmits to the driving wheels is the piston effort, that is, its area multiplied by the initial steam pressure. This, with but a very slight reduction for friction in the cylinder and in the rod stuffing box, is borne by the main rod, either as a tensile stress as the piston is pulled into the cylinder, or as a compressive stress tending to bend it in the direction of its least width as the piston is thrust out. The centrifugal force caused by the back end whirling around the crank and being thrown upward and downward causes transverse stresses, reaching a maximum in the outer fibres, alternating from tension to compression and vice versa for each revolution.

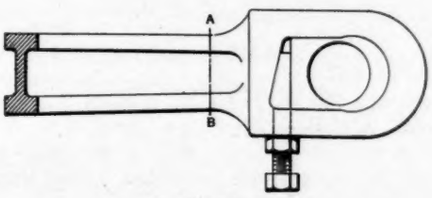


Fig. 1.

The sectional area required to resist the pull of the piston is a simple matter of dividing the total piston effort by some predetermined and allowable stress per square inch. The weakest part of a main rod is usually the front end, either the strap or the bolts, and where the rod is made of I section it is the grooved part immediately back of the stub or solid end. Often the front and back ends are made in proportion to the diameter or size of the crank and wrist pins to which they are connected—made to "look right," irrespective of the force which has to be transmitted—and as a consequence the crosshead wrist pin being comparatively small, the front end connections are made to harmonize. Leaving out for the present all questions relating to the strength of the rod to resist bending or buckling when considered as a column or its stiffness as a beam to resist the stress due to the centrifugal force caused by the vertical motion of the rod, as it vibrates up and down, following the motion of the crank pin; the fibre stress per square inch of section should not exceed 8,000 pounds, that is for every 8,000 pounds of piston effort there should be allowed one square inch of metal. This refers particularly to the front end of I section rods, the part just back of the stub where the channelling commences shown at A-B, Fig. 1. In rectangular sections there is usually an excess of metal at this point, so that little attention need be paid to the area, the weak places being in the straps or in the solid ends. In I section rods with strap ends, when the metal is milled out for the sake of lightness, as in Fig. 2, it is desirable to leave the area at C-D slightly in excess of that of the body just back of the strap. This is based on the experience gained from a number of broken rods made of a good quality of steel of 70,000 to 80,000 pounds tensile strength. The reason is doubtless due to the fact that the rod at this point is reinforced by the strap and rigidly confined, concentrating the vibrations and minute bendings at the bolt hole, the support outside the hole not being sufficient to compensate for the reduction in strength due to the hole.

The straps or solid front ends should be designed so that the stress at the weakest part, usually at the key or bolt holes, should be less than 8,000 pounds per square inch, the working stress could then be taken as ranging from 6,000 to 8,000 pounds. If one side only is reduced by reason of a hole or keyway, the area for both sides should be taken as twice the weakest side and not the actual net area.

Unlike the parallel rods, the normal force transmitted through the main rod is not increased to any material extent by unequal adhesion, improper quartering, etc., therefore the fiber stress may be taken at a much higher figure.

Viewing the rod as a column with flat ends its resistance to bending or buckling may be found by means of Johnson's parabolic formulae described in detail in the preceding paper on parallel rods. For convenience they are again given briefly as follows:

Ultimate strength in pounds per square inch, wrought iron columns, flat ends, ratio less than 210

$$P = 34{,}000 - .43\left(\frac{l}{r}\right)^2$$

Mild steel columns, flat ends, ratio less than 190

$$P = 42{,}000 - .62\left(\frac{l}{r}\right)^2$$

Table 1 is calculated from these formulae. It will be found convenient for rapidly determining the correct form of section and the required area of the rod, forming a useful adjunct to

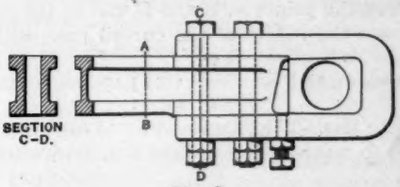


Fig. 2.

diagram No. 6, given in the preceding article. (Page 55, February issue.)

Table 1.

$\left(\frac{l}{r}\right)$	Ultimate Strength Per Square Inch. Wrought Iron.	Medium Steel.		Ultimate Strength Per Square Inch. Wrought. Iron.	Medium Steel.
50	32925	40460	130	26733	31522
55	32699	40125	135	26163	30700
60	32450	39768	140	25572	29848
65	32183	39380	145	24959	28964
70	31893	38962	150	24325	28050
75	31581	38512	155	23669	27104
80	31248	38032	160	22992	26128
85	30893	37520	165	22293	25120
90	30517	36978	170	21573	24082
95	30119	36404	175	20831	23012
100	29700	35800	180	20068	21912
105	29259	35164	185	19283	20780
110	28797	34498	190	18477	19618
115	28413	33800	195	17649	18424
120	27808	33072	200	16800	17200
125	27281	32312			

It is evident that the rod offers the least resistance to bending in a horizontal plane, therefore the width and not the height largely determines its ultimate strength to resist the push of the piston, the greater depth being required to resist the centrifugal force caused by the back end following the path of the crank pin. A factor of safety of from 2.5 to 3 should be allowed, based on the ultimate resistance to bending horizontally in the direction of its least width. As the factor is taken at the elastic limit of the material, it will be found to give an ample margin of strength. A number of rods having a factor of 2.4 have been in service for several years without any known breakages. This applies particularly to rods of I section. Those of plain rectangular section usually have a greater cross sectional area to resist the direct push and pull of the piston, but they have an increased weight without a greater resisting power to withstand the increased centrifugal force.

To design a main rod it is necessary to know in advance the diameter of the cylinder, the boiler pressure, its length from center to center, the piston stroke and the strength of the

material. The maximum piston force which the rod has to transmit is the area of the cylinder multiplied by the boiler pressure. This divided by 8,000 for steel and 7,000 for hammered iron will give the number of square inches required in the smallest part. As most main rods for large engines are lightened by grooving or channeling, a suitable I section having the required sectional area should be selected; from this an approximation to the depth of the section at the center of the rod may be assumed. Find its area in square inches and its least radius of gyration; also the ratio of the length divided by the least radius of gyration. Then from the table take its ultimate strength per square inch. This, multiplied by its sectional area, will be the ultimate bending strength of the rod. The product divided by the piston force will give the factor of safety.

To investigate the action of centrifugal force upon the main rod and to determine the maximum bending moment caused by this force, the weight of the rod, the velocity in feet per second and the radius of the path of the moving body must be first ascertained. Inasmuch as the rod is moving in a straight line at one end, while the other is revolving around the crank pin, it is evident that the centrifugal force is at its maximum at the crank end, gradually decreasing until it becomes zero at the front or crosshead end. In Fig. 3 the elliptic path of a fixed point in the middle of the rod is shown. As the maximum force to produce transverse bending is exerted when the crank is at its highest or lowest position, the velocity between the points A, B and C will be the same as the crank circle, but the radius of the curved path will be much greater. Therefore, as $F = \frac{w v^2}{r g}$ (see page 22, January issue), the force will be less. The simplest way to calculate the bending moment is to make a diagram like Fig. 3, in which:

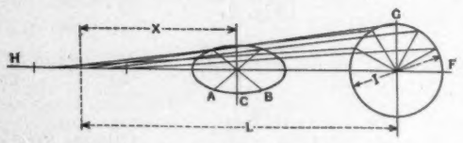


Fig. 3.

L = the length of the rod between centers.
I = the radius of the crank.

The ellipse in the center, of which A, B and C are a part, is the path of the center of the rod. Then the radius of the curve passing through the points A B C can be obtained. Assuming the velocity between the points A and B to equal that of the crank circle, the centrifugal force can easily be calculated by substituting the radius thus found for the radius of the crank. The centrifugal force for any portion of the rod can be found, approximately, by the following formula:

Let F = centrifugal force at crank circle.
X = distance from center of front end to point where the stress is calculated.
Y = centrifugal force at point.
L = length of rod between centers.

Then $Y = \frac{F \times X}{L}$.

As the transverse bending in the center of the rod due to the centrifugal force will be only equal to half that due to the velocity and radius of the crank pin, it will generally be found that the modulus of section, taken at the center, for the usual forms of rods, will be sufficiently large, either of the rectangular or I sections, to provide an ample factor of safety. The force expended in acceleration and the inertia of the reciprocating parts reduces the maximum amount transmitted to the crank pin through the main rod. The minimum effect of these modifying forces is at starting and slow speeds, increasing as the square of the velocity.

The following example is a main rod of a 20x24-inch consolidation locomotive with steam pressure 180 lbs. per square inch and section in center, as in Fig. 4:

Moment of inertia = 3.417, axis perpendicular.
Area of section = 7.78.
Least radius of gyration = .662.
Length of rod between centers = 131½ inches.
Thrust of piston, $20^2 \times .7854 \times 180 = 56{,}520$ lbs.
Material—Steel of 70,000 to 80,000 lbs. tensile strength.
Ultimate strength to resist buckling or bending sideways, axis perpendicular:

$$42{,}000 - .62 \left(\frac{l}{r}\right)^2 = 17{,}700 \text{ per square inch.}$$

$17{,}700 \times 7.78 = 137{,}706$ lbs.

Factor of safety $\frac{137{,}706}{56{,}520} = 2.43.$

The area of section at the front end (minimum section of rod),

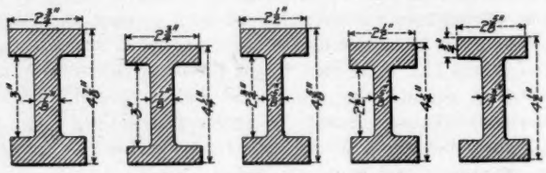


Fig. 4. Fig. 5. Fig. 6. Fig. 7. Fig. 8.

Fig. 5, = 6.07. $\frac{56{,}520}{6.07} = 9{,}311$ lbs. per square inch to resist the direct push and pull of the piston, bending in last instance not considered. A number of engines using these rods have been in service for several years without any known breakages, although the stresses are somewhat higher than usual, more especially regarding the front end.

Another example is that of a main rod of a 20x24 inch ten-wheeler:

Steam pressure, 165 lbs. per square inch.
Section in center, as Fig. 6.
Moment of inertia = 2.49, axis perpendicular.
Area of section = 6.41.
Least radius of gyration = .623.
Length of rod between centers = 111¼ inches.
Trust of piston, $20^2 \times .7854 \times 165 = 51{,}800$.
Material—Steel, of 70,000 to 80,000 lbs. tensile strength. Ultimate strength to resist bending sideways, axis perpendicular:

$$42{,}000 - .62 \left(\frac{l}{r}\right)^2 = 22{,}350 \text{ per square inch.}$$

$22{,}350 \times 6.41 = 143{,}263$ lbs.

Factor of safety $\frac{143{,}263}{51{,}800} = 2.76.$

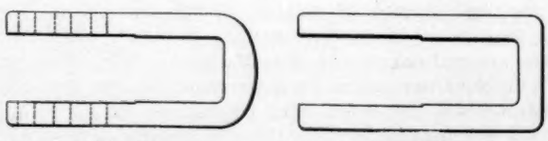


Fig. 9. Fig. 10.

Area of section at front end (minimum section of rod), Fig. 7, = 5.94. $\frac{51{,}800}{5.94} = 8{,}720$ lbs. per square inch to resist in direct push and pull of the piston. No breakages of these rods have occurred in five or six years.

Several breakages are recorded of main rods on eight-wheel engines after a year or less in service. They broke through the bolt holes on the line C—D, Fig. 2, with a stress of about 11,800 lbs. per square inch. The material was steel, with 70,000 to 80,000 lbs. tensile strength.

A third example is that of a main rod of an 18x26 inch ten-wheel engine:

Moment of inertia = 2.366.

Area of section = 6.19, Fig. 8.

Least radius of gyration, .618.

Length of rod between centers 108 inches.

Thrust of piston, $18^2 \times .7854 \times 180 = 45{,}720$ lbs.

Material—A number of the engines were built with rods of hammered iron and others with rods of steel, 75,000 to 85,000 lbs. tensile strength.

Ultimate strength to resist buckling, per square inch of section, 23,230 steel, 20,830 hammered iron. Ultimate strength of steel rod $= 23{,}230 \times 6.19 = 143{,}790$ lbs.

$$\text{Factor of safety} = \frac{143{,}790}{45{,}720} = 3.14.$$

Ultimate strength of hammered iron rod $= 20{,}830 \times 6.19 = 128{,}930$ lbs.

$$\text{Factor of safety} = \frac{128{,}930}{45{,}720} = 2.8.$$

Area of section at front end = 5.81 square inches (minimum section of rod). $\frac{45{,}720}{5.81} = 7{,}870$ lbs. per square inch.

Stress at solid front end, see Fig. 1 (section through set screw hole), $\frac{45{,}720}{7{,}125} = 6{,}410$ lbs. per square inch.

For two or three years 50 or 60 engines using this main rod have been in service without any breakages.

Straps for the Front End.—Fig. 9 shows a form of steel strap used on a number of engines for several years without any breakages. The maximum stress is 8,175 lbs. per square inch (minimum section through the bolt holes). Two straps, made of steel from the same specifications, as in the preceding case, on different engines, broke after a few months' service through the keyways or bolt holes, at a nominal stress of 10,830 lbs. per square inch.

Another case is recorded of a hammered iron strap, Fig. 10, in which the nominal stress of the minimum section through the bolt holes was 12,170 lbs. per square inch. This strap broke through the corner where the stress was 7,000 lbs. per square inch after running for three years and four months. Probably this failure in the corner was caused by the improper design of the end or by injury to the metal in forging.

CAR FRAMING.

By C. A. Seley.

The paper and discussion by Mr. F. M. Whyte, Mechanical Engineer, C. & N. W. Ry., reported in the November proceedings of the Western Railway Club under the above title, and the editorial comment in the "American Engineer" (page 17, January, 1899), has doubtless interested those who have to do with the car question. The necessity for strengthening cars to carry increased loads due to the quite general desire to raise capacities, and on account of the structural weakness of many of the older designs, raises the question of how the increase of strength may be provided in the cheapest and most effective way. Doubtless this was the main object of the paper, although the theories are believed to be applicable to new designs.

There is apparently a basis for the belief that a light bolster can be favored by rearrangement of the truss rods and needle beams, but careful reading shows that this is applicable to special conditions that do not always obtain. To favor the bolster other parts must be strengthened at perhaps equal cost, and many will say: Put it where it belongs in the bolsters. All the stresses due to the lading, weight of the structure and the shocks of uneven rail come back to the bolsters, which constitute the foundation. The lading may be even or very uneven, and the design should provide for all such variations. The framing must stand pulling and buffing strains, whether loaded or empty. Strengthening of old cars must be confined mainly to the bolsters, truss rods and needle beams, as a rearrangement of sills is generally impossible.

Wooden and steel car construction are two very different propositions, and it is to the former that Mr. Whyte's theories seem mainly applicable. The favorite idea in steel car design seems to be the strong back bone in the center, so arranged that the weight of the outer lading can be transmitted to it by suitable connections. This idea cannot be carried out in wooden cars. It is impossible to put in the width or depth of center sills that would make these members comparable with the fishback or deep girder construction possible with steel. We have therefore to resort to truss rods, and at once the problem changes. Most modern cars for miscellaneous traffic are from 36 to 40 feet long, and the distance from center to center of trucks is therefore 25 to 30 feet. There are many cars 45, 46, and in some extreme cases 50 feet long. The so-called sills of these cars are not sills as a matter of fact. Placed over supports the distance apart of their trucks they will hardly carry their own weight, and not even this without considerable deflection. No matter how many sills are put in the deflection is considerable unless they are supported by truss rods and cross sustaining timbers. These sills are then the chord of a truss; they become compression members and are only sills in sections as, for instance, between the needle beams and between the needle beams and bolsters, and they act as a cantilever or an end supported beam from the bolsters to the ends.

Leaders in car design tell us that full carrying strength for the loading should be provided in the lower frame, and that the house or superstructure should not be depended upon to carry any considerable part of the load, for with central side doors the upper framing is an incomplete truss, like a bridge truss with the center diagonals left out. This is undoubtedly the correct view of the matter, although the side sills are greatly stiffened by suitable upper framing except between the door posts, and therefore wooden cars of any considerable length must be provided with truss rods of sufficient strength to carry the load transmitted to the needle beams. The side sills have to carry the weight of the superstructure as well as a portion of the load, and are generally trussed, the rods transmitting their loads to the ends of the bolsters. If the side sills are not trussed the needle beams take the portion of the load transmitted to them by the side sills and carry it to the nearest truss rod, and thence the strain travels to the bolsters. This load measured at the bearing or queen post may be considerable, increased as it is by the lever arm over which it is carried. The spacing of the sills and the location of the truss rods may be such that the load will be transmitted very differently than is ordinarily supposed. This will be treated later on. According to the writer's observation most six-sill cars have the side and intermediate sills trussed, leaving the center sills untrussed. They are secured to the bolsters, and the needle beams take the same deflection as the other sills under the load, but are more free to take their proper duty in receiving the pulling and buffing strains. Some will say that more than four truss rods are preferable, and for large, wide cars more than six sills are needed. This, however, is a matter of opinion, and the writer does not favor more than six sills in any ordinary car, and would use a short sill over the needle beams to help support the floor in the doorways of wide cars. He would also prefer four heavy truss rods to a greater number of lighter ones, taking care to secure ample bearings for the end washers on the end sills.

In order to analyze the strains due to lading let us take a car 40 feet long inside, uniformly loaded, with the center of the transom five feet from the end inside, or a 36-foot car with a 4-foot 6-inch overhang, in either case the overhang being one-eighth of the total length. This one-eighth will balance the

same amount on the other side of the bolster, making one-quarter of the load to be transferred direct to each body bolster by the sills. This leaves one-half of the load to the needle beams to be brought back to the bolsters by the truss rods.

The accompanying illustration, Fig. 1, shows the arrangement of the sills and truss rods very commonly used, it being that of a car 8 feet 6 inches wide inside. The disposition of the load to the sills over the bolsters is shown as follows:

On each side sill	14%
" " intermediate sill	22%
" " center	14%
	$50 \times 2 = 100\%$

The disposition of the load on the truss rods is arranged on the assumption that it is transmitted without deflection of the needle beams, and a more exact arrangement would be that given by calculating the concentrated load on each sill, and thence to the supports in relation to the position of the sills over the rods. The present arrangement will suffice, however, for the present purpose. The distribution gives:

Truss rod No. 1	15%
" " " 2	35%
" " " 3	35%
" " " 4	15%
	100%

Contrary to first thought, the outer rods are very lightly loaded, carrying less than half of the load of the inner pair. In actual practice, however, the weight of the superstructure, deflection of the needle beams and other reasons probably lessens the discrepancy, but it is a fact based on observation of the effects that inner truss rods give evidence of greater loading.

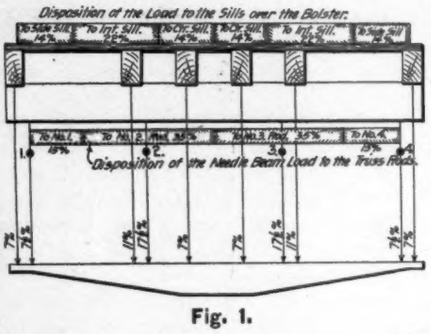


Fig. 1.

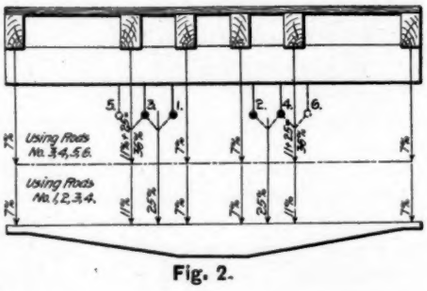


Fig. 2.

Car Framing. By C. A. Seley.

Referring again to Fig. 1, we may drop the load on each sill and rod to the bolster shown below (dividing each amount by two in order to make the total 100 per cent.) and see that the ends receive 14½ per cent. and that 71 per cent. is carried within 21 inches on each side of the center. Now remove the outer truss rod to the intermediate sills, as shown in Fig. 2, using rod positions Nos. 3, 4, 5 and 6, thus giving these sills a double support, which is brought to the center line of the sill by suitable arrangement of the queen posts. The needle beam load thus being carried at two points symmetrically arranged divides into two equal portions of 50 per cent. each. Dividing this by two and bringing it down to the bolster, adding it to the load on the intermediate sills over the bolsters, makes a total of 36 per cent. at the 21-inch point from the center, the load from side and center sills remaining the same as in Fig. 1. If the rods are moved still nearer the center by using the positions shown by rods 1, 2, 3 and 4 and the combined queen post as before, brings the truss load of 25 per cent. seven inches nearer the center, leaving all sill loads the same as in Fig. 1.

Thus it is plainly demonstrated that the nearer the center the more the bolster is favored. In the last named case half of the lading of the car is carried at points 14 inches from the center of the transom. It is done, however, at the expense of carrying 7 per cent. of the load, the amount transmitted to each end of the needle beams over a lever arm of 38 inches from weight to bearing. No ordinary needle beam could withstand the bending stress set up between the center sills by such a load. The necessity for strengthenging the needle beams is very apparent if for any reason it is necessary to put the load upon them in that way. It seems, however, wiser to add to the strength of the bolster if any change is made. A shallow bolster may often be strengthened by well designed filling in place of possibly a few little thimbles. Mr. C. A. Schroyer, Superintendent of the Car Department, Chicago & Northwestern Railway, has recently designed a very effective strengthener for weak bolsters (see "American Engineer" February, 1899, page 45) by using a secondary truss on the center sills supporting the bolsters at the side bearings under the intermediate sills. Figs. 1 and 2 both show that this is a very desirable point to strengthen, and that the center sill load can be most profitably increased, being directly over the center plates. Even though the secondary truss should have to pass over both intermediate and center sills in some constructions supporting the ends of the bolsters, those of slight depth can be economically strengthened. By closely locating the loads and stresses many old cars can be greatly strengthened and the way opened for solution of what has been quite a difficult problem.

WATERVILLE SHOPS—MAINE CENTRAL.

In 1887 the Maine Central erected a repair plant at Waterville, Me., to handle the rolling equipment of the road. These shops embrace the machine and erecting shop, blacksmith shop, boiler shop, passenger and freight erecting shop, mill and paint shop, all of the buildings of brick and well designed and located according to the requirements of the service at that time. They are model shops now, notwithstanding the increase in size of power that has so recently entered as a disturbing element in the provision of facilities for keeping a locomotive in shape for economical road work. This they are doing with the 157 engines of all sorts and builds, besides taking care of their 4,400 cars, with an average force of 100 men in the motive power department, and an average of 140 men in the car department.

There are no specially occult processes of reaching results by Mr. Amos Pilsbury, Superintendent of Motive Power, but simply the old well known devices put to good uses and fostering an esprit de corps among the men that cannot help but influence the returns. The same spirit pervades the transportation department under the General Superintendent, Mr. Morris McDonald, one of the youngest officers holding such a position. He believes in Brown's methods of discipline, and says the right way to handle men is by the golden precept—"Be Fair."

Mr. William McIntosh, for many years Master Mechanic of the Chicago & North-Western Railway, at Winona, Minn., has been selected to succeed Mr. C. A. Thompson, who has just resigned as Superintendent of Motive Power of the Central of New Jersey. Mr. McIntosh has earned the distinction of being one of the best motive power officers of the Northwest, and his appointment is fitting, as he will bring a very wide and successful experience to his new position.

SOME CAST STEEL LOCOMOTIVE DETAILS.

Atchison, Topeka & Santa Fe Railway.

Mr. John Player, Superintendent of Machinery of the Atchison, Topeka and Santa Fe, has gone extensively into the merits of cast steel, and finds it so satisfactory in construction and in service that he is using it liberally in the construction of new engine as the dome, and comprise the frame and jaws in one piece, the swing hangers, and the radius bar. The frame alone as shown in the engraving weighs 461 pounds, the hangers weigh 24 pounds each, and the radius bar weighs 238 pounds, all weights finished. Except the hangers, these details are not easy to make in the smith shop, even when in detached parts, as the frame is made when forged. Again, there is an opportunity for correct distribution of material in the cast product,

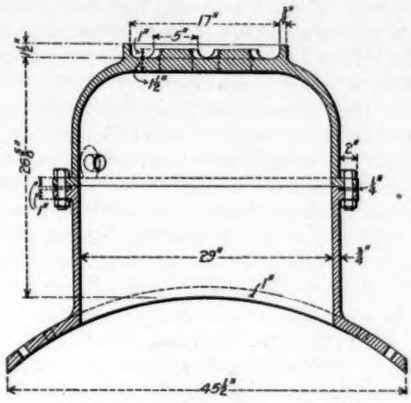


Fig. 1.—Steam Dome.

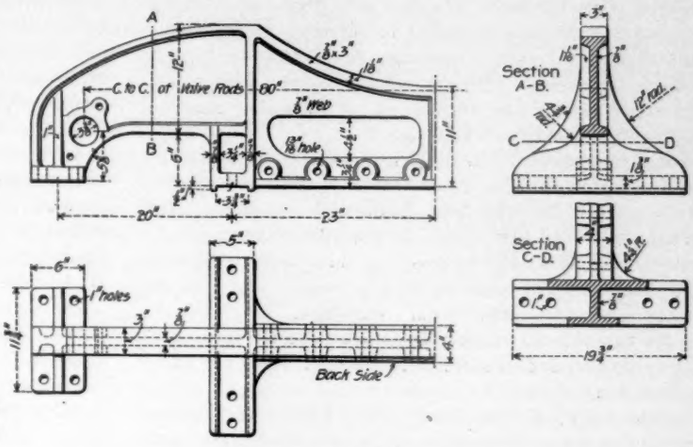


Fig. 3.—Guide Yoke.

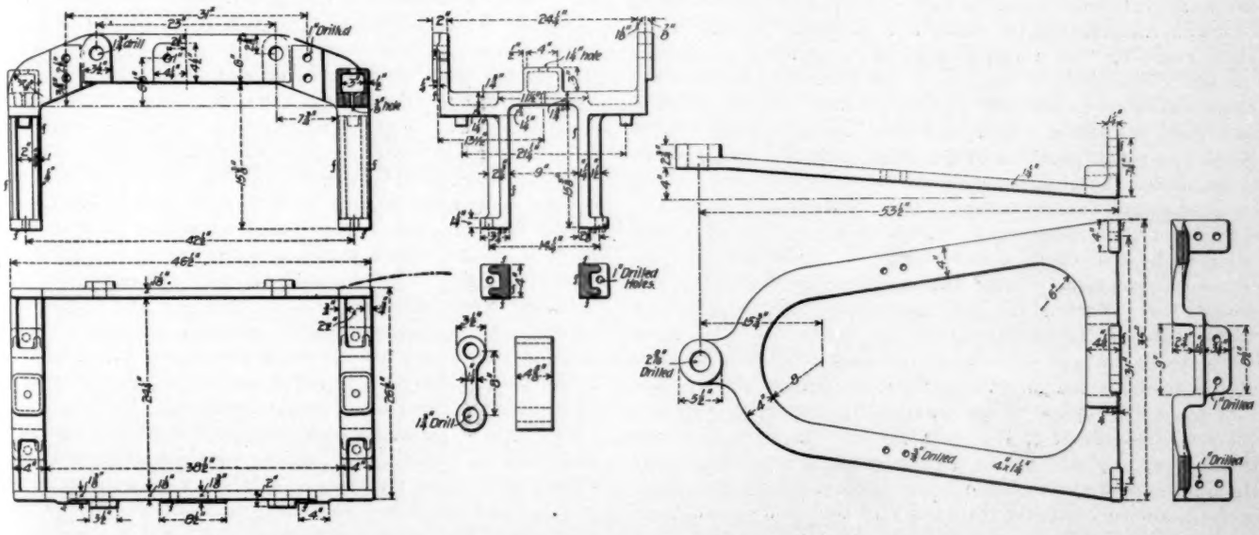


Fig. 2.—Locomotive Truck Details. Cast Steel. Atchison, Topeka & Santa Fe Ry.

MR. JOHN PLAYER, *Superintendent Motive Power.*

heavy engines. This material is to be used for the frames of twenty-five locomotives now building by the Baldwin Locomotive Works for this road, and we are informed that those already in service are entirely satisfactory. An experiment is now being made with cast steel steam domes, the construction of which is shown in Figure 1. This dome is used on a number of 21 by 28 inch consolidation engines, and it offers the advantage of giving ready access to the throttle valve and steam pipe. The dome is made in two parts, which are held together by flanges, bolted with ⅞ inch bolts. The parting of the two sections is a little lower than the middle of the height and thus exposes the throttle so that it may be easily applied, removed or repaired. The body of the dome is ¾ inch thick, while the tap is increased to 2½ inches thick at the pop valve holes. The weight of this dome is 1,372 pounds, of which the upper section weighs 530 pounds.

The engine truck details, shown in Figure 2, are for the same like ribbing, reinforcement and losses, which are impossible to make in a forging as cheaply as in a casting. This is also true of the guide yoke shown in Figure 3, which could not be forged in the form given to the casting. We have no figures for the weight of this part, but it shows a design apparently as light as is consistent with strength.

These parts are representative of those that Mr. Player makes in cast steel, but the drawings do not cover all of them, and we shall return to the subject in a future issue. We believe that there are 2,000 freight trucks having cast steel bolsters on this road, and not a single one has failed. There seems to be no hesitation on the part of the Atchison road to use cast steel on a score of unreliability.

"When the most conservative railroad running out of Boston adopts brick arches and single exhaust nozzles it is time to admit that something is settled and that the world moves."—F. W. Dean, before the New England Railroad Club.

INSPECTION AND CARE OF AIR BRAKES.

Lake Shore & Michigan Southern Railway.

The air brake has done so much to advance the interests of railroads that the care necessary to insure the good order of the equipment ought not to be given grudgingly, yet it is not evident that all roads are giving enough attention to this important part of maintenance. Through the courtesy of Mr. A. M. Waitt, General Master Car Builder, and Mr. H. F. Ball, General Car Inspector of the Lake Shore & Michigan Southern Railway, we are permitted to describe the practice of that road in inspecting and repairing air brakes at Buffalo. These efforts to increase efficiency of brakes are seen to produce immediate results, and are well worth what they cost, and they deserve to become more general.

The work of inspection, testing and repairing of the air brake equipment on cars for movement over the Lake Shore & Michigan Southern Railway from Buffalo, is performed after the cars are assembled into trains on the classification tracks. Ordinarily, the work is done by two men, both being competent air brake men, who are together able to inspect and care for about 300 cars per day under usual conditions. When a train is ready for inspection, connection is made at the front end with the yard line and the train is charged with air at 80 pounds pressure.

To expedite the work, very good results have been obtained by charging the train in sections of 10 or 15 cars, one man going ahead to release hand brakes, couple up the hose, and to properly set the handles of angle cocks, cut-out cocks, release valves and pressure retaining valves; the other man following to make examination for leaks and to repair them. When all is ready for test a service application of about 20 pounds reduction is made from the rear of the train, and the cars are again examined to see that the brakes have applied properly and that the piston travel is within the prescribed limits. When the repair work in conjunction with this examination is completed the brakes are released from the front end, and the cars again examined to see that all brakes have released.

In order that detention to trains on account of air brake work be kept down to a minimum, it is necessary that the work of inspection, testing and repairing be done in a systematic way. Material for repairs should be in close proximity to the different inspection tracks, the lighter material being carried with the men, to avoid unnecessary trips from one end of the train to the other. In all cases where cars require such extensive repairs to air brake equipment as to seriously delay the movement of the train through the yard, they are marked out and sent to the regular repair track, where they are taken care of by a separate repair force. It is the aim to allow no air brake cars to leave the yard with the air brakes cut out or inoperative. In exceptional cases, where the freight is of a perishable character, and the repairs to the air brakes would cause serious delay, cars are allowed to go forward bearing defective air brake cards.

An air pressure of 80 pounds is used in the test, in order to more readily discover weak and porous hose. A higher pressure was used at one time, but was unsatisfactory owing to the liability of cars leaving the yard with reservoirs charged too high, resulting subsequently in the dragging of brakes. The 80 pounds pressure is maintained uniformly by means of a reducing valve located between the main reservoir, which carries 100 pounds pressure, and the yard supply pipe.

From records at hand, a very marked reduction is shown in the number of air brake hose burst in trains which had received the yard test. Comparing the number of hose burst in trains which received the yard test with an equal number which did not receive the test, the ratio is about as 1 to 3. To some extent the difference may be accounted for in the greater efficiency of the men doing the air brake inspection; their inspection being more rigid than that of regular car inspectors, who have to look for other car defects equally important, if not more so. The yard test develops the fact that about 50 per cent. of the cars need attention in the way of renewals of gaskets, tightening up of leaky joints, renewals of hose, repairs to angle cocks, and cleaning of cylinders and triple valves, and oiling of cylinders. In some cases it is necessary to give the whole air brake equipment on a car a general overhauling, including the proper securing of the pipes to the car body, instead of their being suspended loosely by hangers that were never intended to keep them in one position. It has also been found necessary in a number of instances to thoroughly clean and repair the cylinders and triple valves of cars that had just previously gone through the owners' shop and had received general repairs, including repainting and lettering. Apparently all the attention given the cylinders and triple valves, while at the shop, was a new coat of paint.

Proper care is not at all times exercised by repair men in making air brake repairs, due in some instances to lack of proper tools. For example, in the application of gaskets to hose couplings, the lower edge of the gasket is being cut off, making a beveled edge, which permits the easy application of the gasket, but in a short time it requires renewing on account of leakage. By the use of a proper tool for removing the rust from the gasket seat in the coupling, the gasket may be easily applied, and will make an air-tight joint. In removing broken angle-cock handles, and replacing them with new ones, the angle cocks are oftentimes damaged, and left in leaky condition by the carelessness of repair men, or because of not having proper facilities for doing the work. The same criticism applies to other parts of the air brake equipment.

The experience thus far obtained emphasizes the necessity for similar plants at other large terminals, and is seen to be necessary for each road to take care of its proper proportion of the freight air brake equipment in use. By such distribution of the work each terminal will be able to maintain a higher standard of efficiency than is possible under present conditions. One of the most important items of repair work is the periodical cleaning of cylinders and triples. To properly look after this work each year, on a road having a large freight equipment, and to have it done with little delay to loaded cars in transit, means that advantage must be taken of each station where inspectors are located; to have such points furnished with proper tools, and a specific number of cars per month assigned to have cylinders and triples taken care of. By so doing, this work will not be congested at the large terminals and it will reduce detentions to loaded cars to a minimum. This idea is being carried out gradually on the Lake Shore & Michigan Southern Railway.

The men at all points were first given instructions in the air brake instruction car. Later, tools were furnished them from time to time for the proper performance of their work. At small stations, where air supply for testing is not available, hand pumps have been furnished. In this way the work at the large terminals will not be so great as to materially affect the prompt movement of loaded cars towards their destination. It should be the practice of all roads not to allow an empty air brake car to leave the shop or inspection station repair track without testing the brake, and cleaning the cylinders and triple valves, if they have not received attention in that respect within the proper time.

Under the topic, "A Consideration of the Best Arrangement of Air Testing Plants for Large Terminal Points," on page 72 of the proceedings of the Master Car Builders' Association for 1898, will be found a discussion by Mr. Ball, of the equipment needed for such a plant as is referred to in this description, the one described before the association being at Buffalo. This equipment includes a steam air compressor, with 8 by 8 inch steam and 14¼ by 8 and 9 by 8 inch air cylinders, a storage tank of 100 cubic feet capacity, a 2 inch main pipe connecting the storage reservoir to the 1½ inch branch pipes extending along the repair and inspection tracks. Four lines of 1¼ inch pipes, with connections spaced 50 feet apart, complete the equipment for 6 repair tracks. In the inspection yard, 7 1¼ inch lines serve 14 inspection tracks, and connections for hose are furnished at 100-foot intervals.

ANTHRACITE COAL BURNING, NEW YORK, ONTARIO & WESTERN RAILWAY.

The location of the New York, Ontario & Western Railway through an anthracite coal region renders a large amount of "culm" available for fuel, and through the courtesy of Mr. Geo. W. West we have received drawings showing the arrangements of grates which have been found successful with this fuel.

Culm is fine refuse which has accumulated for years around the coal breakers, and it is very cheap. A great many experiments have been made with this fuel in stationary practice, and it has also been used to some extent in locomotives. The results of Mr. West's experiments have been to reduce the cost of fuel about one-half, and at the same time he has succeeded in arranging the grates so as to make the locomotives steam freely. We are informed that ten locomotives are now fitted to burn culm, a number having been changed for this purpose by the Cooke Locomotive & Machine Co.

A comparison made between an engine fitted to burn culm and another of almost exactly the same size of the older arrangement carried out for a period of two months showed the following results:

No.	Mileage.		Fuel Coal.		Lbs. per Mile.		Cost per Mile.	
	Engine	Car.	Lbs	Cost.	Engine.	Car.	Engine.	Car.
Culm, Engine 13...	1.372	4.258	98,596	26 88	71.8	23.1	1.959c	0.631c
Bitn'ns. Engine 77.	1.346	4.193	67,007	53.60	49.8	16.0	3.982c	1 276c

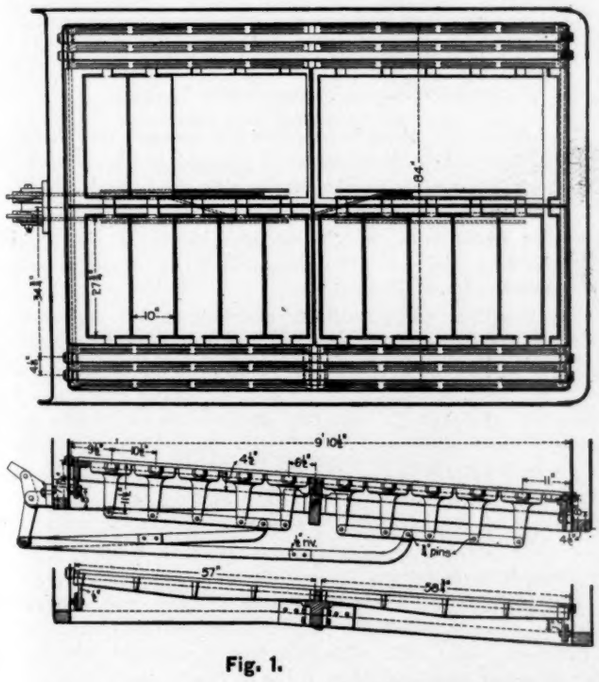


Fig. 1.

which were shallow at the sides, trouble was found in keeping the ashes clear, and a further objection was found in the necessity for using grates which were odd sizes. The division of the grate area into four sections permits of cleaning the fires very quickly, and also avoids trouble from ashes lodging in the upper sides and corners of the ash pan. Incidentally it is worth noting that the grate areas of the two types of locomotives shown are 71 and 80 square feet; the grates are 7 feet 6 inches by 9 feet 6 inches and 10 by 8 feet; the fire doors are elongated, and are 12 by 36 inches in size.

Mr. West has given us a statement of the cost of fuel per train mile and per car mile for the past ten years, as shown in the following table:

Year.	Cost per Train Mile. Cents.	Cost per Eng. Mile. Cents.	Cost per Car Mile. Cents.
1898	11.37	9.71	1.160
1890	11.57	9.56	1.105
1891	12.08	9.59	1.027
1892	11.79	9.33	.945
1893	11.64	9.13	.900
1894	10.84	8.62	.845
1895	9.74	7.61	.726
1896	8.81	6.83	.647
1897	8.59	6.72	.618
1898	8.46	6.56	.618

In 1889 there were 85 locomotives on the road, 71 of which were in service and using bituminous coal, except in the case of three engines which were using lump anthracite. At present the equipment includes 133 engines, with 110 in service, 67 of which have wide fireboxes burning anthracite coal.

A new process for making briquettes of petroleum refuse has been introduced in Germany. In this process about 10 per cent. of soda lye, with 10 per cent. of any other kind of fatty matter—tallow, for instance—is heated in a boiler, and 90 parts of petroleum refuse is added to the heated mass. This mixture is then heated, under constant stirring, for about an hour, care being taken to prevent the temperature reaching the boiling point of petroleum. In this incipient state of saponification the mass will take up large quantities of fluid rock oil, and if this incorporation proceeds too slowly or remains incomplete it may be hastened by adding a little soda lye. The mixture is run into molds and allowed to cool, when it may be cut into pieces of any desired form. Coal dust, sawdust, or other refuse may be added during the process of manufacture, according to the use for which the briquettes are destined, and if it should be desired to obtain a product of less consistency the grease may be entirely or partially replaced by resin, the product in either case having more than 80 per cent. of petroleum, more than 90 per cent. of combustible substances, and less than 5 per cent. of incombustible residue.—"Iron Age."

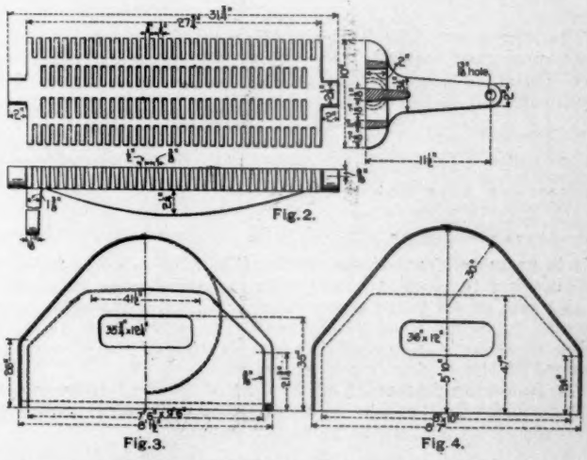


Fig. 2.

Fig. 3.

Fig. 4.

Anthracite Coal Burning—New York, Ontario & Western Railway.

MR. G. W. WEST, *Superintendent of Motive Power.*

The statements are not in terms of ton miles, but the figures appear to be comparable.

The arrangement of grates adopted is shown in Fig. 1. Fig. 2 shows the standard grate, and Figs. 3 and 4 present sections of the fire boxes, which are of the Wootten type, used with this fuel.

The arrangement of grates has been made a standard on the road, and Fig. 1 shows it to be a combination of shaking grates, stationary grates and water bars. The shaking grates are in four sections, divided by longitudinal and cross bearers. The standard grate shown in Fig. 2 is used in all sizes of fire boxes.

Mr. West, after trying a number of different combinations of grates and water bars, has found the one illustrated to be the most satisfactory. He first tried shaking grates, which were the full width of the fire box, but on account of the ash pans,

HEAT INSULATION OF LOCOMOTIVE BOILERS.

The losses from a locomotive boiler by the radiation of heat and the values of several different boiler coverings as insulating material have recently been investigated on the Chicago & Northwestern under the direction of Mr. Robert Quayle, Superintendent of Motive Power, and reported by him in a paper before the Western Railway Club. The tests were under the supervision of Mr. Waldo H. Marshall, Assistant Superintendent of Motive Power, who was assisted by Mr. F. M. Whyte, Mechanical Engineer of the company, while the manufacturers of the boiler coverings were represented by Prof. William F. M. Goss, of Purdue University, who formulated the results of the tests. The scheme of the tests, briefly, was to test the boiler of a standard eight-wheel engine with and without covering, and both running and standing, and base the efficiency of the various coverings on the amount of condensation. The boiler of the test engine was not fired up, but received steam from an engine coupled at the rear, which furnished the power and pushed the test engine over the road.

The test boiler had 0.61 of its total surface covered in the experiments on the coverings. The total surface includes all surface except that of the smoke box. The covering included the dome, cylindrical part of the boiler and the wagon top as far down as the top row of stay bolts, stopping at the cab, the boiler head and the side of the firebox were not covered. This amount of covering is that usually provided in common practice. The quantity of moisture in the covering was found to affect its efficiency, as would be expected. It was also found that cement coverings were very nearly equally as efficient as the others when thoroughly dry. The thickness of covering was found to have an important influence on its efficiency; that is, that which showed 62 per cent. efficiency could be made to give 64 or 65 per cent., or more, by increasing its thickness. This 62 per cent. represents the proportion of saving of all the heat radiated from the same boiler when uncovered, the saving being due to the covering of 61 per cent. of the exterior surface.

That the power loss from radiation is a considerable one in the unprotected boiler and worthy of consideration in the covered boiler is seen by the table giving results under both conditions:

Power Lost by Radiation.

	Horse-power equivalent to radiation losses.
Bare boiler—	
Locomotive at rest	12.
Locomotive running 28.3 miles per hour	25.
Covered boiler—	
Locomotive at rest	4.5
Locomotive running 28.3 miles per hour	9.

It is gathered from these results that even when a boiler is well covered the loss in power from radiation when standing is at the rate of 4.5 horse power when the boiler pressure is 150 pounds, as during these experiments, the loss increasing as the boiler pressure is increased, the temperature of the atmosphere reduced or the engine is put in motion.

The following statement of the cost of this radiation will let in some light that will be likely to attract attention to the desirability of its prevention as far as possible:

Cost of Radiation—Uncovered Boiler.

Pounds of coal per hour equivalent to radiation losses, assuming evaporation from and at 212 deg. F. of 6 lbs. of water per pound of coal—	
When standing	60
When running 28.3 miles per hour	126
Tons of coal per month, assuming boiler to be under steam standing 200 hours, and running 28.3 miles per hour during 300 hours per month	25
Cost of radiation per year for boiler tested, assuming the conditions of the preceding paragraph and assuming the price of coal $3.00 per ton	$600

These figures of course have application to a bare boiler only, a condition approached, but never quite reached, by the poorest wood lagging. The annual saving which would be realized by the efficiency of 62.3 per cent. would, therefore, be $600 \times 0.623 = $383.80. It is shown that an increase in efficiency in covering by 1 per cent. will give a saving of $6 a year; an increase of 2 per cent., $12, and 3 per cent., $18, all as shown by the engine tested and under the conditions of the test. The close agreement in uniformity in the results obtained by the different coverings is a matter that will occasion some comment, for the reason that the contrary has been the general supposition; or, in other words, that there was a wide variation in efficiency. There is one point, however, not brought out in the tests, and necessarily impossible under the conditions; namely, the effect on efficiency of a boiler covering by age or long service.

The records of the various coverings is as follows:

Pounds of Steam Condensation per Minute.

	A	B	C	D_1	D_2	E	F_1	F_2	G
Standing test	6.78	2.63	3.42	2.91	2.80	3.52	3.04	3.22	3.03
Running test (Speed, 28.3 miles)	14.27	5.68	5.47	5.03	5.34	5.21	5.29	5.30	5 70

While the reference letters were not identified in the paper or by the manufacturers in the discussion, the following is believed to be a good guess at the various names:

A is the bare boiler, B the plastic cement covering, Sal-Mountain asbestos, used by the Chicago & Northwestern, and the others are believed to be: C, asbestos fire belt; D_1 and D_2, the asbestos sponge felt lagging, these three being made by the H. W. Johns Co.; E, the lagging made by the Chicago Fireproof Covering Co.; F_1 and F_2 and G must be the product of the Keasbey & Mattison Co., and the Franklin Manufacturing Co. The first two are probably the Keasbey & Mattison magnesia blocks, and G we believe to be magnesia blocks by the Franklin Manufacturing Co.

The economy possible of attainment by means of a good boiler covering, as shown in these tests, is certain to lead to renewed efforts by all interested, and at the same time there will no doubt be experiments made to determine the effect of covering other exposed surfaces aside from those in the case noted, say, for example, the cylinders and saddle. If insulation is a good thing to prevent radiation of heat from a boiler, is it not equally as good to prevent loss of heat from the cylinders and prevent condenser action therein? It is probably far more expensive to lose heat in the cylinders and steam passages than in the boiler because of the wastefulness of cylinder condensation in the use of steam. Here the loss is effective in reducing the power of the cylinders.

HYDRAULIC FORGING MACHINE.

Juniata Shops, Pennsylvania Railroad.

The advantages of hydraulic forging presses over hammer work in locomotive forgings were pointed out by Mr. T. R. Browne in his article on the blacksmith shop, on page 188 of our June, 1898, issue, and we now present engravings of a press for small work, which has been in use in the Juniata shops for some time, and is an example of the compactness and convenience of such a machine.

This machine, when working under hydraulic pressure of 1,500 lbs. per square inch, has a capacity of 30 tons, or about 5 tons per square inch of available die surface, this being sufficient for compression of steel under favorable heats. It was originally designed for making switch rod and brake jaws, and with this object in view the dies, instead of being the ordinary 6 inch square blocks, are 6 by 6 by 9 inch pieces. It was soon found that in addition to the class of work mentioned nearly all of the varieties of special upsetting in connection with bolts could be done, and also the manufacture of track and shop wrenches from the straight bar.

The machine has a main ramming cylinder and a gripping cylinder. The stroke of the main cylinder is limited by a screw adjustment, and both cylinders have automatic pull-backs, both of which are illustrated in the sectional views, that of the main cylinder being enlarged to show its construction more clearly. The operating valve shown in Fig. 1 is so constructed that in starting up the machine the gripping cylinder operates its ram first, gripping the work, and the main ram follows. In the reverse operation the main ram retreats first and the gripping ram afterward.

This machine has sufficient capacity to upset and form hand rail columns complete, as well as a variety of similar work, and it has been found particularly successful in certain intricate shapes which it is desired to finish in a single heat, this being chiefly due to the fact that the speed of the ram is sufficiently slow to permit the metal to flow. It has been found that work in several difficult cases which could not be done with the usual speed of the ram was successfully formed when the speed was reduced, and this experience seems to indicate the necessity for being able to adjust the speed to the different kinds of work.

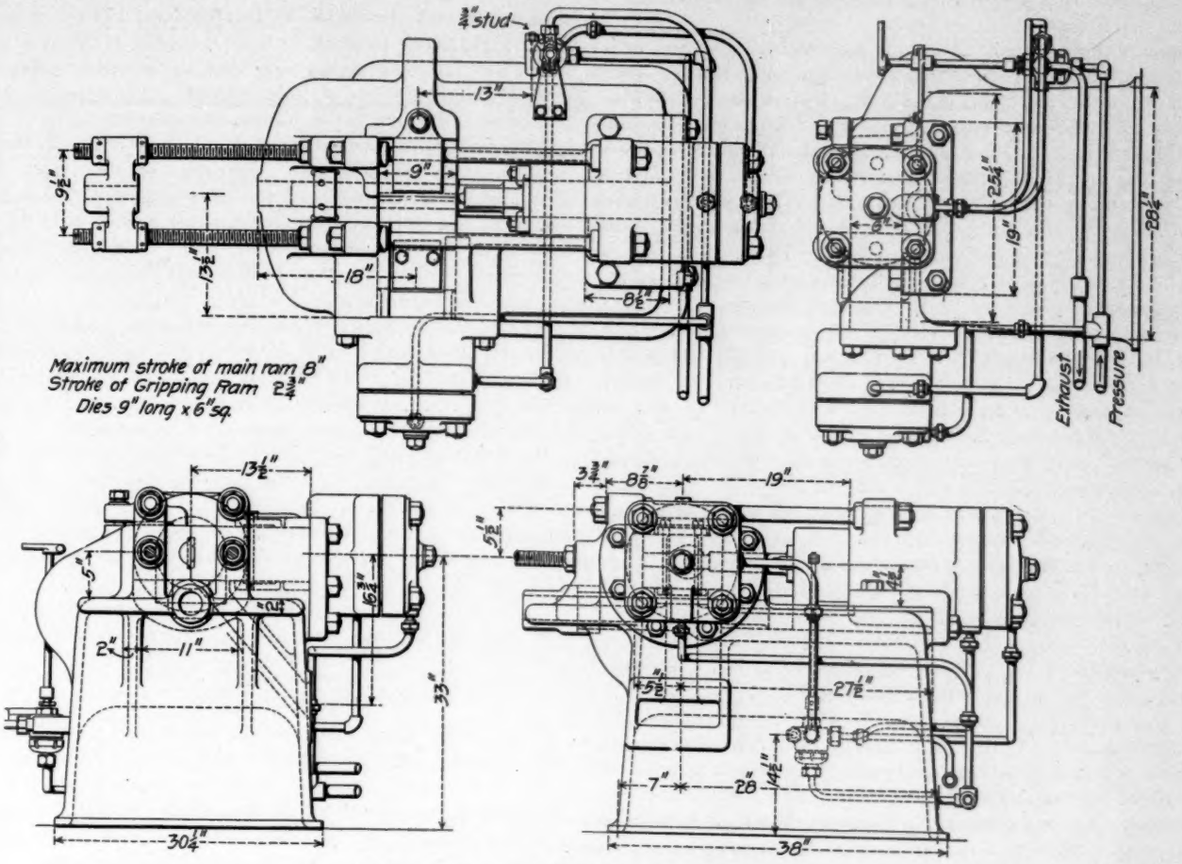


Fig. 1.—Plan and Elevations of Machine.

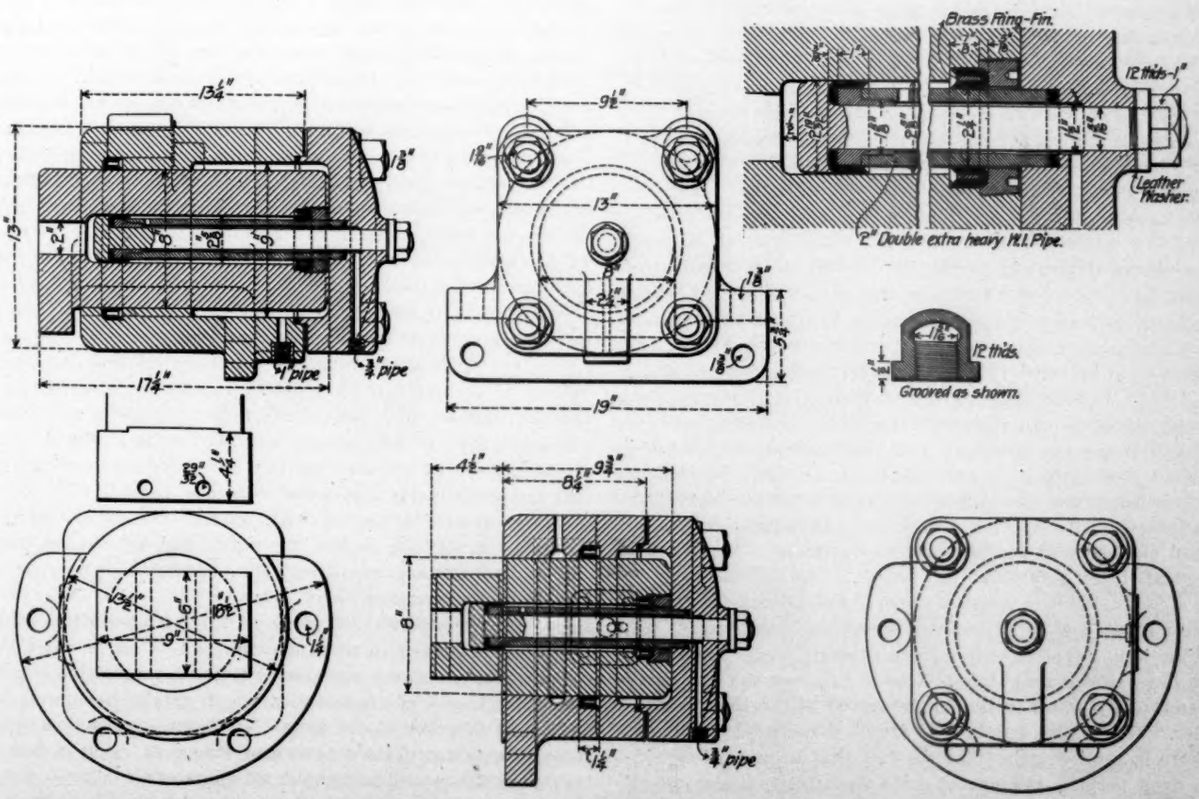


Fig. 2.—Sections of Cylinders and Pull Backs, Hydraulic Forging Machine.—Juniata Shops, Pennsylvania Railroad.

CYLINDER RATIOS FOR COMPOUND ENGINES.

Custom and precedent in compound engine practice have usually confined the cylinder ratios between comparatively narrow limits, which are about as follows: Ratios of 1 to 2.75 and 1 to 3.25 in European stationary practice, 1 to 3 and 1 to 4 in similar practice in America and England, while compound locomotives are usually made between limits of 1 to 2.5 and 1 to 3. A common rule in stationary practice has been to make the diameter of the low pressure cylinder 2 inches less than twice the diameter of the high pressure cylinder.

The question of the correctness of these limits has been boldly and consistently presented by Mr. George I. Rockwood, who expressed his views in our columns in 1891 in an article entitled "How Many Cylinders Will It Pay to Introduce in the Multi-Cylinder Engine?" That article was written before the author had the support of experimental results for his views, and he has recently advocated the unusual ratios of 1 to 8 in a paper read before the Providence Association of Mechanical Engineers, a complete report of which may be found in "The Engineering Record" of January 7, 1899. Mr. Rockwood goes farther than that, and believes that the intermediate cylinders of triple expansion engines are better omitted. He says:

"For stationary power plant engines the most economical engine at present practically possible, all things considered, is, in my judgment, a cross compound engine, working with a boiler pressure of 180 lbs., a vacuum of 13½ lbs., a receiver pressure of 8 lbs. and a cylinder ratio of 8 to 1."

He also says:

"I believe * * * that a pumping engine of largest size, working with practically no clearance, with steam at a boiler pressure of 180 lbs. and a cylinder ratio of 8 to 1 would give the horse-power on a consumption of less than 11 lbs. of steam and a coal consumption of 1 lb. per horse-power hour."

The explanation of the proportions selected for usual practice is that an engine so proportioned reduces the "drop" of pressure from the end of expansion in the small cylinder to the cut-off pressure in the large cylinder to the minimum, and at the same time gives reasonable ratios of expansion in each. In other words, the "drop" is considered a most serious loss, and great pains are taken to avoid it. Mr. Rockwood, however, shows that there are two reasons for "drop," and believes that advantages accompany moderate use of it. He incidentally points to the increase in steam pressures which have come into use during the 30 years of efforts to reduce "drop," and says that we know high ratios and high pressures are more economical than low ratios and low pressures. No foundation is found for the supposed error in permitting "drop" in the receiver of a compound engine, but while it is always wasteful, such waste should not be a controlling factor in the determination of ratios.

Clearance is believed to be "the chief cause of preventable waste," but intermediate receivers should not be associated in the same category with clearance spaces.

The two causes for drop are: (1) "Intermediate expansion," i. e., when more steam by volume leaves the receiver than is put into it per stroke (presupposing that no steam is either made or condensed in the receiver itself), and (2) cylinder condensation and clearance in the low pressure cylinder. "Drop" may be prevented by adjusting the cut-off. The cut-off may be either a corrective or a cause of "drop," and if adjusted to prevent it a great deal of cylinder condensation may result. On the other hand, experiments on the Sibley College laboratory engine have shown that "drop" acts to improve the quality of the steam and prevent initial condensation in the low pressure cylinder. This shows a gain by "drop," considered thermally, and there is another gain from the fact that the use of considerable drop permits the use of wide variations in the cut-off in the second cylinder without looking at the end of expansion in that cylinder or materially reducing the receiver pressure.

Mr. Rockwood's position might be considered a radical one were it not supported by practical experience in the form of 25,000 horse-power in eight large compound condensing engines built with the ratios he recommends. These were sold under a guarantee to work with an economy of 12½ lbs. of dry steam per horse-power per hour, and the guarantee was in all cases surpassed. One of these engines is referred to by the author of the paper in the following quotation:

"The very best performance of any mill engine which has been tested by recognized and competent experts is one of this type running at the mills of the Grosvenordale Company and tested by Mr. Barrus, who published his report in "The Engineering Record" of November 20, 1897. The steam consumption was 11.89 lbs. total per indicated horse-power hour, and the coal consumption was 1.18 lbs."

In tests comparing a triple expansion engine and a compound, with Mr. Rockwood's ratio, at Sibley College, reported in the "Transactions" of the American Society of Mechanical Engineers, Vol. XIX., it was shown that the compound did as well as the triple on heavy loads and better on light ones.

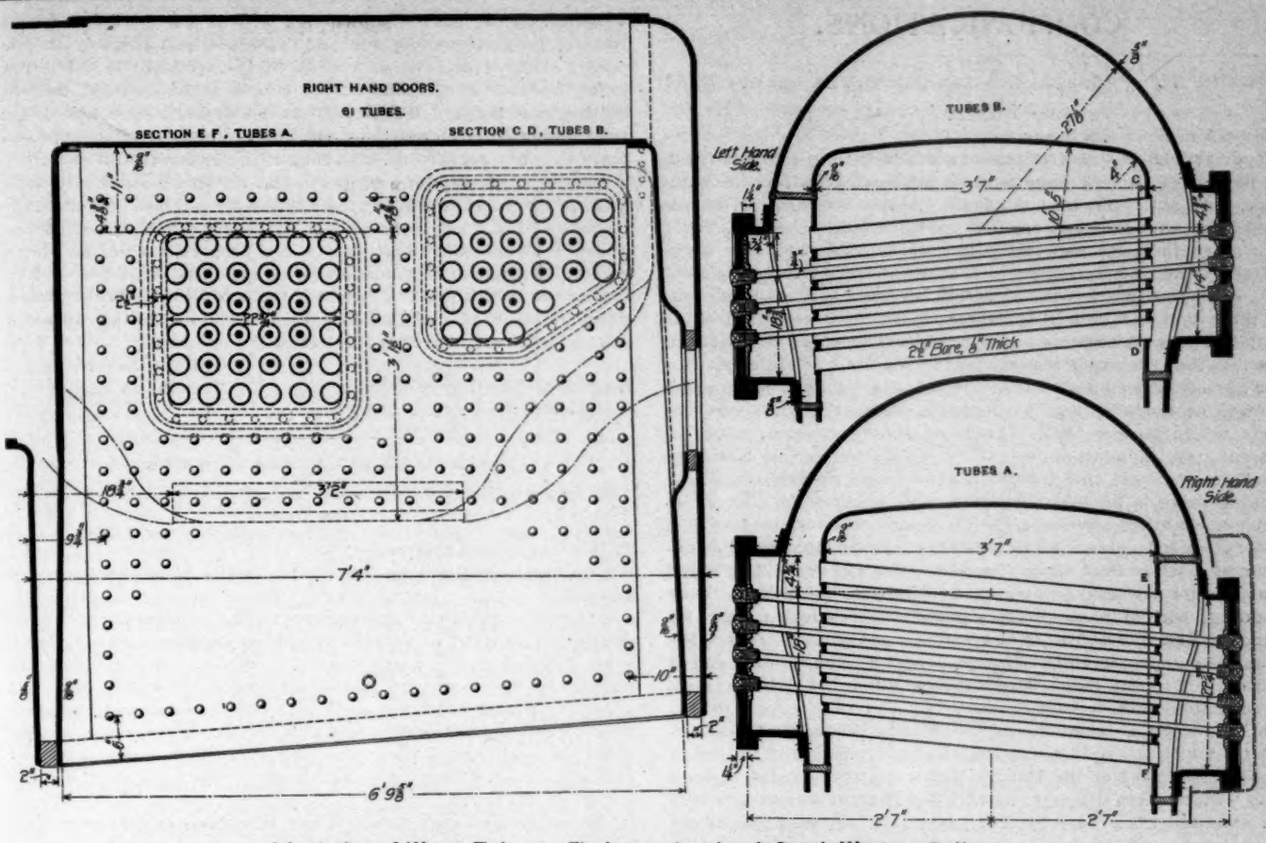
Mr. Rockwood says that these experiments at all events make it perfectly plain that cylinder condensation does not depend directly and solely on the range in the temperature of the steam, and that the extent of the surface exposed and the amount of "drop" that is allowed has at least as much to do with it.

WATER TUBES IN LOCOMOTIVE FIREBOXES.

London & South Western Railway.

If the water tube principle can be adapted to torpedo boat boilers, which offer some of the very severe conditions which exist in locomotive practice, there are grounds for hope that the advantages offered by this type may be available to locomotive designers. Water tubes have been used some years for supporting fire-brick arches in locomotive fireboxes, and the superior value of the relatively small amount of this kind of heating surface is everywhere admitted. An extension of the same idea, carried out in practice on the London & South Western Railway, from designs by Mr. D. Drummond, Locomotive Superintendent of that road, is shown by courtesy of Mr. Drummond in the accompanying engraving. Attempts have already been made in the United States to use water tube boilers, but nothing, so far as we can recall, has been done practically in the way of combining water tubes with the usual features of locomotive boilers. Mr. Drummond uses two nests of transverse tubes, in this case 2½ inch, across the firebox, the groups being inclined in opposite directions, as indicated. These tubes add about 160 square feet of firebox heating surface to this particular boiler, and the designer says that they produce a rapid water circulation in the space between the internal and external firebox sheets where the absence of active circulation has hitherto been one of the outstanding defects of the locomotive boiler. Access doors or man-holes are provided at each side of the firebox opposite the ends of the tubes for the purpose of examination and repairs. The firebox shown in the drawing is 6 feet 5 inches long by 3 feet 7 inches wide inside and 6 feet 6 inches deep.

In the case of a firebox with outside dimensions 8 feet 4 inches by 4 feet 6½ inches, the tubes add 215 square feet to the heating surface, or 13 per cent. of the total heating surface is in the form of water tubes, while 21 per cent. of the total heating surface of a boiler of this size is in the firebox. The boiler referred to in this paragraph is small when compared with American practice, but it is interesting to note that three nests of these tubes which might be placed in a firebox of the size of the Great Northern 10-wheel passenger engine illustrated in the "American Engineer" issue of October, 1898, page 328, would add about 350 square feet of firebox heating surface in the form indicated in the sketch. The total heating surface of the Great Northern boiler as it stands is 2,677 square feet, which might be raised to 3,025 square feet by this arrangement, the additional weight of the tubes being

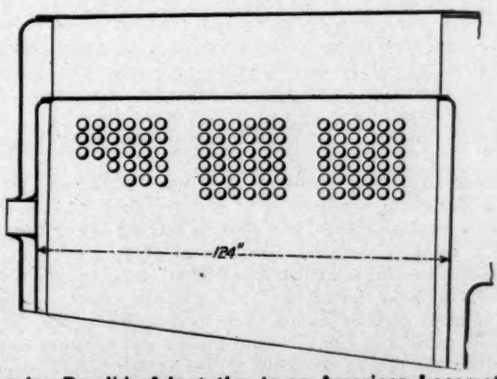


Adaptation of Water Tubes to Fireboxes—London & South Western Railway.

MR. D. DRUMMOND, *Locomotive Superintendent.*

but 1,649 pounds, and the total increase of weight, not including the water in the tubes, probably about 2,500 pounds.

Mr. Drummond uses 24 tubes in the rear nest and 36 in the forward one. Stay rods are carried across the firebox through 10 of the tubes of the rear nest and through 16 of the other group. These are secured by adjustable right and left hand threaded nuts screwed through the cover plates and over the rod ends, while the plates are secured also by studs to the cast steel union pieces. The tubes are straight and short. They should be easy to clean, and with these lengths there will probably be no trouble from expansion. The stay rods



Showing Possible Adaptation to an American Locomotive.

are not exposed to the fire, and they are so disposed as to act favorably in supporting the flat cover plates.

The unmistakable support of water tube boilers by Engineer in Chief Melville of the United States Navy furnishes additional grounds for viewing this type of boilers with favor and with the substantial endorsement of Mr. Drummond's adaptation the subject of water tubes seems worthy of more than passing notice. We think it worthy of a trial, especially in view of the fact that passenger locomotives are now being designed with tubes 16 feet long.

It would be easy to put in too many of these tubes for boilers using bad waters owing to the difficulty of getting at the ends of the main body of boiler tubes in order to keep them tight by caulking, and there is also danger of putting in so many as to bring the bottom rows so low with relation to the grates as to quench the flames before combustion is completed, but it appears to be possible to secure a material increase of heating surface without going too far in either of these directions.

TABLE OF PISTON PRESSURES.

The following table was unintentionally omitted from one of Mr. Cole's articles on "Working Stresses of Materials." The table gives piston pressures on cylinders from 7 to 24 inches, inclusive, at boiler pressures of 160, 180 and 200 pounds, and will be found useful in computing stresses in piston rods, crank pins, side and also main rods and driving axles, as far as piston pressure is concerned in the strength of the two latter details. It is thus seen that the little table is of considerable scope in finding stresses in the parts subjected to forces transmitted through the piston, and, while simple in itself, will save time and calculation:

Piston Pressures.

Diameter of Cylinder.	Area.	Steam Pressure 160 lbs.	180 lbs.	200 lbs.
7	38.5	6160	6930	7700
8	50.3	8048	9054	10600
9	63.6	10170	11448	12720
10	78.5	12560	14130	15700
11	95.0	15200	17100	19000
12	113	18080	20340	22600
13	133	21280	23940	26600
14	154	24640	27720	30800
15	177	28320	31860	35400
16	201	32160	36180	40200
17	227	36320	40860	45400
18	254	40640	45720	50800
19	283	45280	50940	56600
20	314	50240	56520	62800
21	346	55360	62280	69200
22	380	60800	68400	76000
23	415	66400	74700	83000
24	452	72320	81360	90400

COMMUNICATIONS.

POWERFUL PASSENGER LOCOMOTIVES FOR FAST TRAINS.

Editor American Engineer:

Your article on powerful passenger locomotives for fast trains on page 52 of current issue is most interesting, but at the same time, I do not think that it should cause much surprise among those who have studied carefully the questions presented. When you state that the especial points to be observed are "large boilers, large and direct steam passages, easily moving valves," etc., etc., you hit the nail squarely on the head, as every one of these points is a telling factor in the final result. I think that this is well understood as a general proposition, but it is possible that the exact reasons "why" may not be entirely clear.

It has often been stated that the old style of light valve gears allowed so much spring in the parts, that at high speeds, the ports would barely open. The more solid construction of the present day, in addition to the balancing of valves, has done much to overcome this trouble, and we believe that the piston type of valve is by long odds the most progressive and satisfactory. Another advantage is the long ports obtained with a moderate-sized valve. As an instance, the original Purdue experiments, when Prof. Goss found the "critical speed," or speed of maximum power to be about 200 revolutions per minute, were conducted with an engine having ports 16 inches long for a 17 by 24 inch cylinder, whereas in the recent tests of Prof. Smart the ports were approximately 18 inches long for cylinders 9½ and 16 inches by 18 inches long. The immense advantage of the latter in ports alone will be seen at once.

In 1896, when a committee of the Master Mechanics' Association (of which the writer was chairman), investigated the effect of the Allen valve at the Purdue Laboratory, the value of long ports was very readily seen, as will be apparent to any one who will examine Plate 16 (opposite page, 186), in the Proceedings for that year. These results frequently showed over 50 per cent. increase in mean effective pressure for the Allen valve at high speeds and short cut-offs. The following year, in reporting on cylinder ratios, the question was still further investigated, and diagram No. 3 on page 197 of the "American Engineer" for June, 1898, shows that at high speeds a great advantage is gained in having long ports.

Now, if these improved valves and ports admit more steam into the cylinders, they will evidently need a more plentiful supply of steam, hence the large boiler is a necessary accompaniment of the better valve. Where the curve at a given cut-off falls, as in the Purdue simple locomotive, it signifies that the valves will not admit all the steam which the boiler can deliver, but should this curve at some speed become horizontal and remain so, it would indicate that the capacity of the boiler, or steam pipes, had been reached. Where the curve always rises, as far as the experiments go, it shows that the capacity of the boiler has not been reached. Now, a compound locomotive, not using as much steam per I. H. P. will evidently not reach the limit of boiler capacity as quickly. We think that this, and the larger port openings, as illustrated by Fig. 1 (page 52, "American Engineer," February, 1899), considered in the light of the above, will explain the point under discussion.

In one way the several diagrams given in your editorial are misleading; the origin does not commence at zero as it should to give a perfectly clear idea of the exact nature and relation of the curves to each other. Prof. Smart speaks of this in his letter of Jan. 18, 1899, and also of the valves of the simple engine not admitting the full amount of steam. For instance, Fig. 3 at first sight gives the impression that the mean effective pressure for engine 1027 was constant at all speeds, but if the origin were extended to zero, where it belongs, it would be found that the locus curved downward to meet the origin. This shows a slightly falling mean effective pressure with increases in speed, and is in accordance with the diagram above referred to in the June number. Some diagrams prepared by the writer and presented on page 63 of the "Railroad Gazette" of Jan. 27 show the same divergence in the power curves as in Fig. 3, and these were prepared theoretically by assuming different lengths of ports. Tangents to these curves at points of high speed would intersect as in Fig. 3, but these should be really curves, as they must both start from zero. Several isolated points shown near the lower left hand portion confirm this assertion.

Following up our analogy, we therefore conclude that the divergence in the curves shown in Fig. 3 is due to the different relative proportions of ports and cylinders, and possibly to different sizes of drivers, as the speed is expressed in miles per hour, instead of revolutions. Of course it is assumed that in neither case has the capacity of the boiler been approached, for then under all circumstances, the curve of power must approximate to a horizontal line. The four-cylinder compound evidently gives the advantage of long ports and moderate sized cylinders, and we think this an advantage which should not be underestimated, as intended to be shown by diagram No. 3, but in the absence of specific details as to the proportions of the single expansion engine, it is impossible to say just what Fig. 3 does represent. With the units in which the co-ordinates are shown, a great number of curves could be drawn, all giving different angles, by simply varying the size of the cylinders.

G. R. HENDERSON,
Mechanical Engineer.

Norfolk & Western Railway.
Roanoke, Va., Feb. 8, 1899.

AIR BRAKES ON HEAVY CARS.

The Lake Shore and Michigan Southern Railway Co.
Car Department.
Cleveland, O., Feb. 9, 1899.

Editor "American Engineer:"

I am interested in your editorial on page 50 of the February number.

It is quite difficult to decide what is the best method of procedure with regard to air brakes in heavy capacity cars. There is no question that a great deal of inefficiency in air brakes on trains can be overcome, if the air brake apparatus was not abused by being neglected, both as to adjustment and cleaning. There is no doubt that it is desirable to have a car which weighs 36,000 lbs. and carries 110,000 lbs. of lading, with means for providing a greater braking power than 70 per cent. of the light weight of the car.

I have thought that it would not introduce unnecessary and impractical complications if the air brake people should devise a means of throwing additional pressure into the cylinder when these heavy capacity cars are loaded up—such extra pressure being restricted when the cars are running light. It is not found impractical on mountain roads to use the retaining valve—the trainmen being held responsible for properly turning the valve when the cars are going to run down long and heavy grades. It would seem to my mind perfectly practical to have a valve (which might be called a brake reinforcing valve), located on heavy capacity cars, which should be so connected with the air supply as to restrict the amount of pressure that should be admitted into the cylinder when the cars are running light, and should allow the full amount of pressure to go in when the cars are running heavy. Such cars could be equipped with a cylinder of large diameter, so that with a low pressure of air admitted into the cylinder they would give the ordinary 70 per cent. of braking power, and with the full 70 lb. pressure admitted they would have a considerably increased braking power. Such a valve would be something in the form of a reducing valve—the handle when turned in one direction allowing the air to go through the reducing valve and be reduced to a proper point, and when the handle was turned in the other direction it would allow a direct connection between the auxiliary reservoir and the cylinder.

As to slack adjusters, doubtless they would from one point of view be a desirable acquisition to a car. They add, however, considerably to the expense if a road is buying 500 or 1,000 cars. There is, I think, a serious objection to putting on too many automatic devices on a railroad, whether it be in the form of signals, self-locking switches, or automatic slack adjusters. With all of these improvements there is a tendency for the personal factor to be lost sight of, and unless the men are held responsible for the proper working of mechanisms, and attention called to the duties which they would be expected to perform if the automatic devices were not in use, they are apt soon to neglect these matters and consider that the automatic devices can be depended on always to do the work that formerly they had to do. When such a condition exists there is liable to be an unexpected accident at some time, in which case the newspapers have occasion to make the statement that "the automatic device did not work," whereas if the devices applied to the equipment had been properly looked after by the men, and they had assumed that they were to exercise the same vigilance as they would if the special device had been absent, no accident would have hap-

pened. I think a conservative position in connection with such devices is a wise one. Many of the automatic devices in use are blamed for faults that would not exist if it were not for the fact that the companies using them allow their employees to depend on the automatic features and neglect the proper inspection and care of the apparatus. This condition is, perhaps, most forcibly illustrated by the conditions developing in the M. C. B. automatic coupler, due to lack of proper inspection and maintenance.

Returning to the subject of air brakes on cars of large capacity, I think that a field is now opened up which calls for ingenuity, and the bringing out of some simple device which—with the co-operation of the trainmen—will enable the roads to make the braking power of loaded, heavy capacity cars, more nearly in line with what it is on the present light capacity cars.

A. M. WAITT,
General Master Car Builder,
Lake Shore & Michigan Southern Ry.
Cleveland, Ohio.
February 9, 1899.

Editor "American Engineer:"

Your editorial in the February number, page 50, entitled "Air Brakes on Cars of Large Capacity," calls attention to a matter which needs more general consideration than it has heretofore received.

While the capacity of the new 80,000 and 100,000-pound cars is an increase of from one-third to two-thirds above the 60,000-pound cars, the light weight of the new cars has not been correspondingly increased, and as the braking power is proportional to the light weight, the result is that these cars, when loaded, are braked to a lower percentage than the 60,000-pound cars.

When trains are made up exclusively of these large capacity cars, as is the custom on some of the principal coal and ore lines on which they have been adopted, this reduction in the percentage of braked weight makes no difference in the handling of the train, but when a few loaded 100,000-pound cars have to be run in the same train as 60,000-pound cars, the conditions are not favorable for smooth handling of the train. If the 100,000-pound cars are placed next to the engine, which seems to be the preferred practice of the trainmen, a burst air hose or broken coupling behind the heavy cars will invariably cause the train to separate sufficiently to come together with more or less destruction, unless there are a number of non-air brake cars at the rear end, enough to overcome the braking power and cause the rear section to maintain the same speed as the front section of the train, so that the gap will be closed up as soon as steam is shut off on the engine. On the other hand, if the 100,000-pound cars are placed behind the lighter air brake cars, the former will, on account of their greater inertia, jerk the engine back when starting, or when the slack runs out, perhaps with sufficient violence to break the train in two.

There is no real need of increasing the capacity of box and stock cars above the 60,000-pound mark, and, these cars being principally used for high class freight, which the present policy is to move on a faster schedule than required by the coal and ore traffic, the natural tendency is to separate the heavy gondolas from the rest of the freight car equipment. As long as these conditions prevail, it seems, therefore, unnecessary to make special provisions for handling 100,000-pound gondolas and 60,000-pound box cars together in the same train. If these gondolas have to return empty, they are on the same level as other empty cars as far as braking power is concerned, so that that phase of the question need not be considered.

Your suggestion, that proper application and suitable care of the present braking arrangement would meet the conditions of service, covers the subject as far as the requirements go of the high capacity cars under the conditions above stated. In order to keep up the efficiency of the brakes on these cars the inspectors must be made to give special attention to them, particularly to the adjustment of piston travel on loaded cars. Slack adjusters do certainly a great deal to keep up the braking power to the intended percentage, but it must be borne in mind, that on cars with the brakes suspended from the body, or with trucks of the Schoen type, on which the point of suspension is not constant with relation to the wheel, the slack adjuster must be of the kind that also pays out slack, so that when it has adjusted itself for a loaded car, it will not give too short piston travel and consequently too high braking power when the car is empty.

EDW. GRAFSTROM.
P., C., C. & St. L. Ry.
Columbus, Ohio.
Feb. 7, 1899.

Editor "American Engineer":

I read with interest your article on "Air Brakes for Cars of Large Capacity," and believe you are not far wrong when you say that trucks and cars have often been so designed as to render it impracticable, if not almost impossible, to put on a brake that will remain efficient after the car has run for any length of time in the usual service to which a freight car is subjected. A very much more serviceable brake can frequently be had if the beams are hung outside of the wheels. Beams thus hung have the advantage of greater clearance from the track and consequent decrease in liability of being torn off; considerably greater ease of inspection; shoes are more readily applied; and, in my opinion, based on observation, in cases of derailment the truck is less likely to turn out from beneath the car.

Those who favor inside hung brakes argue the brake shoe remains always the same height on the wheel, which is true only when the beams have no spring suspension, without which (as all who have observed know) even the rivets will loosen from constant jar, and the life of the beam and its hangings will be considerably shortened.

The idea of braking all freight cars with one length of levers when the cars vary in light weight from 20,000-pound flat cars to 45,000-pound refrigerators, is gradually going out of practice. The only reason such practice ever had for existence was that the levers of all freight equipment were thus of one size and that no car repairer could make a mistake. But such a repair man, of whom the attempt is made to steer clear, is not to be thus easily circumvented, he now shuffles up to the cylinder and truck levers and guesses which is which.

I like what you say regarding the benefit to be derived from the use of the slack adjuster. It is evident that the greater the braking power on the car the greater the wear of the brake-shoes, and consequently the more frequently must the slack be adjusted. Instead of its being a fortunate thing that there is but one prominently known slack adjuster, I believe it has worked to the disadvantage of both the manufacturer thereof and the railroads. Had the competition been greater, the already moderate price might not have been affected, but I believe there would be more adjusters in use today. I do not see where $5, or less than 1 per cent. of the cost of the car, can be placed to better advantage than in the application of an efficient safety device, such as this certainly is. It must seem to be a trifle peculiar that with a numerical ratio of 30 or 40 box cars to one passenger car, that more slack adjusters—ten times over—should be in use on passenger than on freight cars, especially inasmuch as the former are placed on repair tracks for cleaning and proper inspection and testing of brakes on an average of once every 24 hours. Such inspection cannot be given freight cars.

Inasmuch as you mention the necessity for greater attention being paid to systematic cleaning and oiling of cylinders and triple valves, the writer would like to submit the form of record used by himself for the past three years, by which defective work can be traced to its proper source and the exact amount of such work be ascertained at a glance. [These are clearly described, and are not reproduced.—Editor.] You will note that each page of the record book has 50 numbers, one side of the leaf having the even numbers 00 to 98, while the opposite side has the add numers, 01 to 99. The class of cars can be stamped at the top of the page if desired. As all pages are printed alike, the top of each page is headed by writing the figures above the tens space, then all the clerk has to do is to enter the weekly reports (made on blank form herewith shown) by stamping with a rubber stamp or writing in the proper year column a letter corresponding to the telegraph call of the point where the work was done and a figure indicating the month. The last column in the weekly report serves as a check on the record for previous work. Often work recently done at some point has to be done over again very soon at other places, it is an indication of carelessness or negligence, and in no other way than by some such record as this does the writer see how it is to be known that these men on a large railroad system are doing their work well. They cannot be constantly watched, and ample opportunity is had for slighting this work.

A monthly report shows the amount of work done at each point, the number of foreign cars attended to, and the total amount of work done, giving the percentage to the total equipment of air braked cars. Since we have had this record we have more nearly accomplished the desired end—attention to the freight cars once a year—than we did before.

E. W. PRATT.
General Air Brake Inspector, C. & N. W. Ry.
Chicago, Ill., Feb. 10, 1899.

Editor American Engineer:

I have carefully gone over the editorial in your February issue referring to air brakes on cars of large capacity, and fully coincide with some of your views on the subject, but my opinion is that you did not go far enough, as this is an almost inexhaustible subject. We are practicing many ridiculous features to-day in connection with air brakes on both freight and passenger cars, and some, which it occurs to me, we have very little excuse for. Our brakes are entirely too heavy for the amount of work they have to do, and some effort must be made in the near future to reduce this weight. One of the greatest features for ridicule in our freight car brakes is that we take a car weighing 30,000 pounds and load it with 110,000 pounds of weight, and yet have the same braking power with the 140,000 pound load that we had with the 30,000-pound load. Surely there is room for improvement in this. J. E. SIMONS,

Pittsburgh & Lake Erie R. R. Asst. Master Car Builder.

McKee's Rocks, Pa., February 21, 1899.

DISCIPLINE AND EDUCATION OF RAILWAY EMPLOYEES.

The able article by Mr. G. R. Brown on the subject of "Discipline and Education of Railway Employees," printed on page 35 of our February issue, has brought a flood of letters addressed to the "American Engineer" by progressive officers high in authority on the railways of the United States, showing how deeply railroad managements are interested and how keenly they are following up this most important subject. We deem it advisable to reprint a few of them and regret that we are not at liberty to publish the names of the writers in every case.

Chicago, Rock Island & Pacific Ry.

Chicago, February 13, 1899.

I read Mr. Brown's article with care and was very much interested in it. We have had his system in effect on the Rock Island Road for about two years now, and while I cannot say it has done all that Mr. Brown claims for it, I do think it has been of very great advantage to our company in many ways, and we have no desire to return to the old method of disciplining our men by suspension. Briefly, I think the effect of the system is to improve the personnel of the men in our operating and mechanical departments; this, first, by weeding out the poor and inefficient men, and, second, by stimulating those remaining in our employ to give the company the very best service they are capable of. W. H. TRUESDALE,

First Vice-President and General Manager.

Boston & Maine Railroad.

Boston, February 3, 1899.

My attention has been called to the article in your issue of February, entitled "The Discipline and Education of Railway Employees," which I take pleasure in carefully reading.

LUCIUS TUTTLE,

President.

Flint & Pere Marquette R. R.

Saginaw, February 4, 1899.

The Brown System of Discipline has been in use on the Flint & Pere Marquette for some time past, and is very satisfactory. The matter has been so ably covered by Mr. Brown that any comments from me seem unnecessary. I consider Mr. Brown's article in your paper a very good one. W. D. TRUMP,

General Superintendent.

Minneapolis, St. Paul & Ste. Marie Ry.

Minneapolis, February 9, 1899.

My attention was attracted to the article written by Mr. G. R. Brown on the "Discipline and Education of Railway Employees," under the Brown System of Discipline, in your February number. As you are probably aware, this company is using the Brown System and we find it in every way superior to the former way of handling men, and I heartily concur with Mr. Brown in the sentiments expressed therein.

E. PENNINGTON,

General Manager.

Long Island Railroad.

Long Island City, February 4, 1899.

I have followed closely the advancement and growth of what is known as the "Brown System of Discipline," and know of the favorable results obtained where the system is being followed. I take pleasure in saying that our own experience has been very successful and gratifying.

W. H. BALDWIN, JR.,

President.

Chicago, Rock Island & Pacific Ry.

Chicago, February 13, 1899.

I have read with much interest the article by Mr. G. R. Brown on "The Discipline and Education of Railway Employees," printed in your February issue. I consider this a very able article, and I coincide fully with Mr. Brown in everything which he has said, after having had an experience of nearly two and one-half years under the operation of the Brown System of Discipline. Our employees take kindly to it, and we believe we have improved our service very materially, which means in the end a large reduction in the cost of operating the road. We believe our employees to-day would, to a man, vote against going back to the old system of discipline by suspension.

W. I. ALLEN,

Assistant General Manager.

Southern Pacific Co.

San Francisco, February 7, 1899.

I have read this article by Mr. G. R. Brown, General Superintendent of the Fall Brook Railway, in your February number with much interest. Our experience with the system of discipline devised by him has been most satisfactory, both to the management and to the men. J. KRUTTSCHNITT,

Fourth Vice-President and General Manager.

Chicago & West Michigan Ry.
Detroit, Grand Rapids & Western R. R.

Grand Rapids, February 14, 1899.

My especial attention has been called to the article by Mr. G. R. Brown in the February issue of your paper, for which I am grateful. CHAS. M. HEALD,

President.

The Wabash Railroad.

St. Louis, February 4, 1899.

I find a very valuable article by Mr. Brown in your February number. While I have read a great many of Mr. Brown's articles, I take great pleasure in reading the one in your paper.

J. RAMSEY, JR.

Vice-President and General Manager.

Plant System.

Savannah, February 3, 1899.

I notice in your February issue an article by Mr. G. R. Brown, General Superintendent of the Fall Brook Railway, on the subject of discipline, and take pleasure in reading this article as I have always done similar articles written by Mr. Brown.

B. DUNHAM,

General Superintendent.

_____ ____ Railroad.

_____, February 14, 1899.

I have been following Mr. Brown's career, in connection with the question of discipline, for several years.

I regard the record system of discipline in a sense philanthropic and elevating. It must, it seems to me, nourish the virtue of gratitude on the part of employers and employees alike; the former because of the possible satisfactory results without punishing the families of those who make mistakes, as well as the improved service which it seems to me must come from a careful, conscientious, intelligent application of the system; and the latter in recognition of the many advantages accruing from being allowed to continue to earn wages, notwithstanding their errors which made it necessary to discipline them in one way or another.

As to the matter of education, we must all on general principles agree with Mr. Brown to a certain extent, and I regard this feature as one requiring very delicate treatment. I

believe the best results are to be attained by teaching men to be honest, self-reliant, and to have proper respect for authority, coupled with such training as may be necessary to make them efficient workmen in their spheres. Men of good common sense thus equipped will render better service in the lower ranks, as a rule, than those of higher education.

I realize that I am on the unpopular side of this question; but, believing that there is always a sufficient number of the better educated class of men, desirous and qualified to become good railroad men, to fill the positions of authority, by due course of promotion, I am satisfied that the companies' interests are always safe-guarded in this respect.

Vice-President.

Cincinnati, Hamilton & Dayton Ry.

Cincinnati, February 15, 1899.

Mr. Brown's ideas regarding the disciplining and education of railway men agree with mine. Being personally acquainted with Mr. Brown, I have gone over and discussed the subject with him in detail, and have no hesitancy in saying that his views and ideas are sound, and in accord with my own.

R. B. TURNER,
General Superintendent.

Columbus, Sandusky & Hocking R. R.

Columbus, February 7, 1899.

I came here last October and found nothing that corresponds to the Brown system of discipline. I am glad to see Mr. Brown's article on this subject. There is no doubt but that the principle underlying Mr. Brown's system is of great value and I propose to adopt in substance his method of dealing with my men.

G. H. KIMBALL,
Superintendent and Chief Engineer.

——— R. R.

———, February 9, 1899.

I have read the article by Mr. G. R. Brown, General Superintendent of the Fall Brook Railway, and originator of the Brown system of discipline, with a great deal of care. I have also studied the system introduced by him and have practiced it, as our road had adopted this system of disciplining employees. I was opposed to the system before it was inaugurated on our road, and I have had no occasion to regret the stand I took at the time.

I feel that when a man has disregarded the rules of the company, or through his carelessness or indifference, has caused loss of life and great damage to the company's property, for which the company finds it necessary or expedient to suspend him from the service for a certain period, after the suspension has been lived out the man feels that he has, in part, paid the company for the damage he has done, and he goes to work with a clear mind and with no club hanging over him and nothing to prevent him from exercising good judgment and rendering acceptable service to his company. The most ambitious men that we have on the road are the men who are more liable to commit slight offenses, for which demerit marks, under the Brown system, are assessed. They soon amount up to sixty marks, at which time we know that it is optional with the company whether or not they will dispense with his services. He is then working under a cloud; he is not in a frame of mind where he would render the service he would if his mind was clear; he has had placed upon his ambition a check, and, in short, it places our men in a degree of bondage, that is not, in my judgment, conducive to good service. I am very much opposed to the dismissal of old employees; men who are acquainted with the system, the officers and its rules, but I do believe that the company gets better results, the employees are happier and freer to act under the discipline by suspension than under the Brown system.

I do not write this article for publication, but if you desire to record me as being opposed to the Brown system, I have no objections.

Master Mechanic.

Columbus, Hocking Valley & Toledo Ry

Columbus, February 8, 1899.

I have carefully perused Mr. Brown's article, which appears in your February issue, and take pleasure in saying that I heartily indorse all that he has said on the subject Our experience with the Brown system of discipline is quite satisfactory. We show a decrease in the number of cases of discipline of 28 per cent. in the year just closed, as compared with the previous year, and one of 33 per cent. in the number of debit days accorded. I feel that this system of discipline is by far superior to the old, in fact results show this to be the case. We feel to-day that our service is as nearly perfect as it has ever been, so far as discipline is concerned, and we believe that it is largely due to the interest that the men take in the new system.

M. S. CONNORS,
Superintendent.

Long Island Railroad.

Long Island City, February 4, 1899.

I have read with interest Mr. Brown's article in your February issue. I know Mr. Brown personally, and have had the pleasure of spending some time on the Fall Brook Railroad. I believe thoroughly in Mr. Brown's method of handling men and know that the results obtained are most satisfactory. I have followed the growth of this system with great pleasure and gratification.

W. F. POTTER,
General Superintendent.

REQUIREMENTS FOR BOILER TUBES, UNITED STATES NAVY.

The Bureau of Steam Engineering of the United States Navy Department has recently issued a code of rules covering the requirement for material used in the construction of boilers and machinery for use in naval vessels from which the following in regard to boiler tubes is taken:

Lap-welded Mild Steel and Lap-welded Charcoal Iron.

The naval inspector will select three tubes from each lot of 100, and these will be subject to the following tests:

1. A piece 3 inches long, cut from one tube, must stand being flattened by hammering until the sides are brought parallel with the curve on the inside at the ends not greater than three times the thickness of the metal, without showing cracks or flaws, the bend at one side being in the weld.

2. A piece 1¼ inches long, cut from one tube, must stand crushing in the direction of its axis, under a hammer, until shortened to ¾ inch for stay tubes and to ½ inch for ordinary tubes, without showing cracks or flaws.

3. The end of one tube, cold, must stand having a taper pin, taper 1½ inch to the foot, driven into it until the end of the piece stretches to 1⅓ times the original diameter, without showing cracks or flaws.

The failure to pass any one of these tests will reject the lot of 100.

Seamless and lap-welded mild steel tubes 3 inches in diameter and larger, for steam and water pipes. These must pass requirement No. 1, but requirement No. 2 is altered to the following, and No. 3 is omitted:

2. Two pieces, which have been cut from the ends of two test tubes, shall, after annealing, stand flanging cold to a 1 inch flange, when the diameter of the tube is from 3 inches to 6 inches, or to a 1½ inch flange when the diameter of the tube is greater than 6 inches.

The failure to pass these tests in a satisfactory manner will reject the lot.

INFRINGEMENT OF JANNEY COUPLERS.

Judge Adams handed down at St. Louis, Feb. 14, an opinion in the patent suit of the McConway & Torley Co. against the Shickle, Harrison & Howard Iron Co. The plaintiffs alleged that the St. Louis company infringed their patent on the Janney freight car couplers, on which the complainants claim a patent granted Feb. 21, 1882. Samples of this coupler were introduced in court when the case was argued. The defense was on three lines, unpatentability, anticipation and non-infringement. Judge Adams ruled that the complainant had a clear patent on this novelty, and that it has been infringed. The opinion stated that a decree will be entered granting a perpetual injunction against any further infringement and referring the case to Judge James A. Seddon, for an accounting of the damage sustained by the complainants from the infringement.

SAND DRYING AND ELEVATING APPARATUS.

Chicago, Burlington & Quincy Railroad.

The best arrangement for sand drying systems seems to be still an open question among those most interested in the cheap and efficient hauling of sand for locomotive uses, and we therefore present by courtesy of Mr. G. W. Rhodes, formerly Superintendent of Motive Power of the Chicago, Burlington & Quincy, engravings of what is considered to be an excellent installation at Chicago. The drying stoves, of which there are two, are shown in Fig. 1. These stoves are located between two reservoirs, which are below the floor line, and receive the sand after drying; the sand passing down through a valve in the top of the reservoir. An enlarged view of this valve is shown in section in Fig. 2, and its method of operation by cord and lever is shown in Fig. 1. The sand is elevated to a storage reservoir under which the dryers are situated, by means of compressed air, as indicated by the piping, the arrangement and formations of which need no explanation.

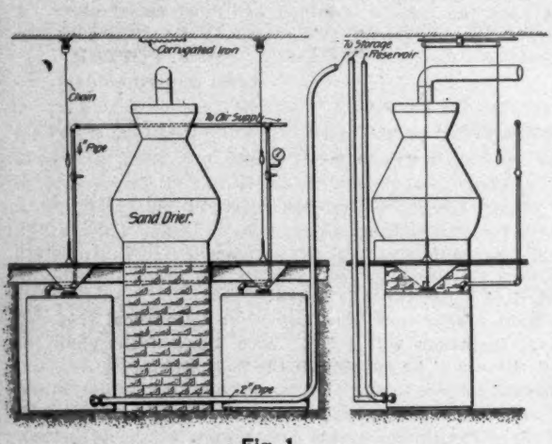


Fig. 1.

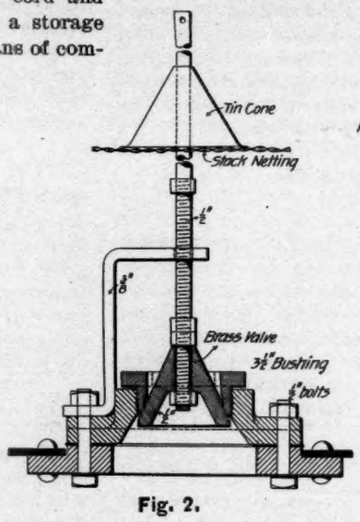


Fig. 2.

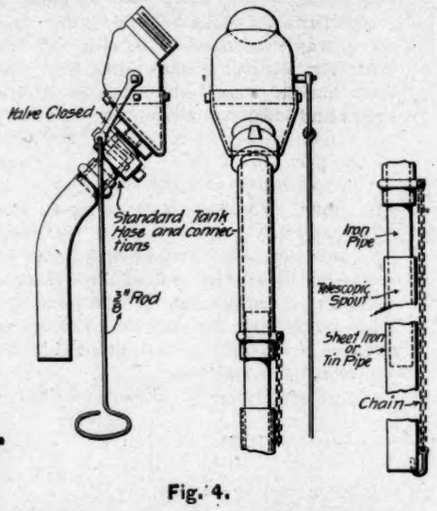


Fig. 4.

A pipe connection to the storage reservoir has a rotary valve which controls the flow of sand to the sand box on the locomotive. This valve is shown in Fig. 3, and Fig. 4 shows the valve coupled up to the hose leading to the sand box, and the handle by which it is operated. Mr. R. D. Smith, Master Mechanic of the C., B. & Q. at Chicago, gave some information on the working of the arrangement under consideration at a recent

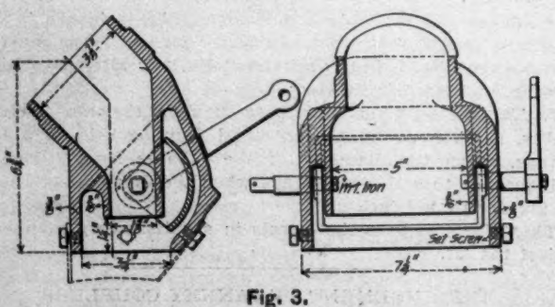


Fig. 3.

meeting of the Western Railway Club, which we reproduce because of its interest in this connection. He said:

"As we use at Chicago large quantities of sand for engines, a description of our plant may not be out of place. I have been looking up the amount of sand that we used last year, and find that from Oct. 1, 1897, to Oct. 1, 1898, we used in round figures 200 cars of sand, or 3,916 cubic yards. We try to unload all of our sand through the summer and fall months, closing up our storage shed in the winter months, when sand is frozen and expensive to handle. Our storage shed for holding the sand is on a triangular piece of ground, with the drying room in one corner. The storage shed, which is covered, is built the same as most sheds used for that purpose, except that instead of unloading the sand at the top of the ground we excavated to a depth of four feet, thinking we could store sand as well below the ground level as above it. The upper portion of the shed is divided into sections, with doors that open inward and upward, so that a car can be run at any place alongside of the shed and unloaded. The sand drying room is a building nineteen feet square, and is fitted with two large drying stores, cone shaped, with the largest diameter down, the latter diameter being 4 feet 9 inches. As the sand dries it is screened into a reservoir holding about six cubic feet. The sifted sand falls through an eight-inch opening, which is closed by a cover cast with some lips that fit in a race, so that an eighth turn draws it down and makes an air tight joint at the top, and after closing the large opening air is admitted through a quarter-inch pipe to the top of the sand, and in less than a minute the sand in the reservoir is elevated through an ordinary two-inch pipe extending from the bottom of the tank upward about 29 feet into a bin divided into two compartments. Each compartment is built like a hopper in a mill, having an opening at the bottom that ends in four-inch pipe with a rotary valve. There is a spout on the outside of the building that is pulled down, and the rotary valve is turned to allow the sand to flow to the locomotive sand box the same as water flows from a pipe to an engine tank. We have used different methods of drying and elevating sand, having tried steam dryers and different air and mechanical elevators, but our present arrangement for drying with the large stoves and elevating by putting the pressure on top of the sand, has been the most satisfactory and economical. We find it costs us to unload, dry and sift 11½ cents per cubic yard. This cost includes taking the sand from the car, drying, elevating and placing in a bin ready to be put in the sand box of a locomotive."

It will be noted that there is a slight difference between Mr. Smith's description of the valve in the reservoir and that shown in Fig. 2, which may be accounted for by improvements constantly going on in the service.

SAND BLAST FOR REMOVING PAINT FROM TENDER TANKS.

The removal of old paint from iron surfaces has always been tedious, expensive and unsatisfactory. Hand scrapers were first used for this work, and while burners, both charcoal and gas, of the Bunsen type, have been employed, and also chemicals, the task is a difficult one that always causes delay and expense. Sand blast apparatus has been most successfully used for similar work in bridge repairing and in ship yards, and the simplicity of the appliances and rapidity of the action of the sand have led to its use in cleaning paint from tanks.

A device of this kind, as used on the Atchison, Topeka and Santa Fe Railway, is shown herewith by permission of Mr. George A. Hancock, Assistant Superintendent of Machinery.

Fig. 1 shows the machine, perfected by Mr. Thomas Paxton, Division Master Mechanic at Fort Madison, Iowa. It consists of a 12 by 33 inch air reservoir, mounted in a vertical position on a pair of wheels, and filled with about 330 pounds of sand. Suitable pipe and hose connections are made at the top of the reservoir to admit air under a pressure of from 80 to 90 pounds, while the sand pipe from the bottom of the reservoir extends down to meet the air pipes.

An examination of the engraving will make clear the working of the device without a detailed description. This machine cleans a 4,000 gallon tank completely in four hours, the reservoir requiring two fillings of sand for each tank. The weight of the arrangement complete is 443 pounds empty and 773 pounds when filled with sand, as noted in our January issue. Fig. 2 shows the machine in operation, where a tank is partly cleaned, the rear half being finished. The special excellence of the work done by the sand blast consists in its ability to take everything off right down to the metal. If there are any pitting where rust is progressing, the sand reaches and removes every vestige of it. As a proof that it does its work well, it is only necessary to say that a tank must be painted soon after the cleaning operation or oxidation will immediately attack the smooth, raw surface if left exposed to dampness.

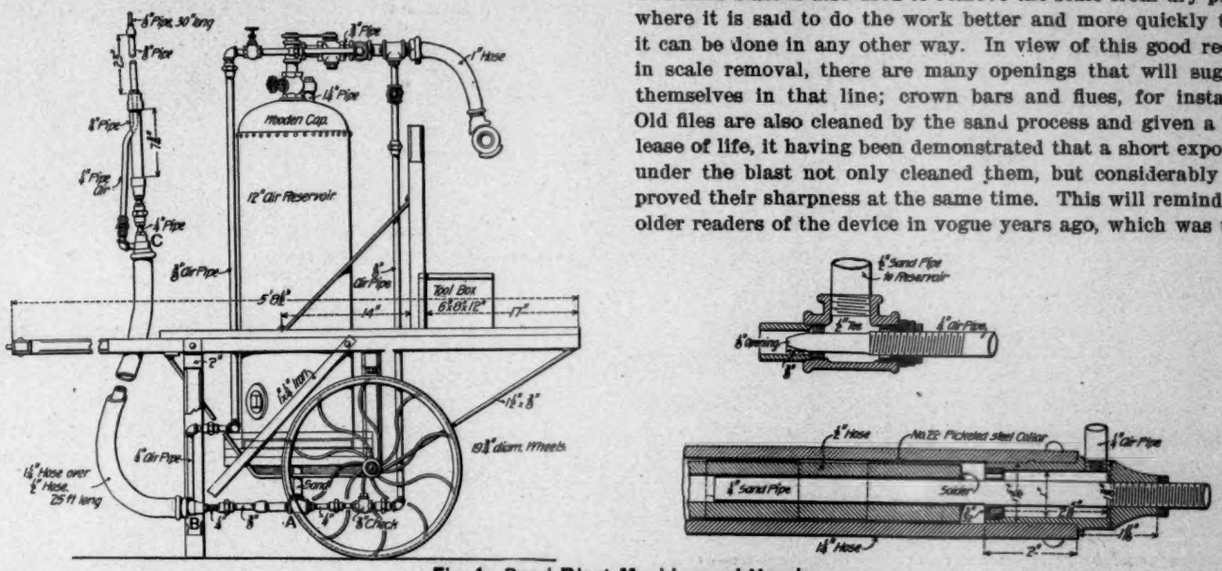


Fig. 1.—Sand Blast Machine and Nozzle.

About 10 cubic feet of sand is the amount used to completely clean one 4,000 gallon tender, including the iron frame. The labor cost is four hours, at 12.5 cents per hour, while the total cost does not exceed 85 cents per tender. The figures show the value of this method of cleaning as compared with the process in which lime was used at a cost of five times that quoted for the sand, and with results that were never as good.

This machine has new fields of usefulness constantly presenting themselves, as shown in Fig. 3, where it is seen cleaning old car journal brasses which required new babbitt. Old brasses were formerly cleaned by a bath of lye, but the sand blast does the work faster and leaves the outer surface looking like new.

This device is profitably used in all places where it is necessary to remove paint, as, for example, on dome and sand box casings and driving wheel centers in case the paint is in such a condition as to require a new surface, complete or in part. The sand blast is also used to remove the scale from dry pipes, where it is said to do the work better and more quickly than it can be done in any other way. In view of this good record in scale removal, there are many openings that will suggest themselves in that line; crown bars and flues, for instance. Old files are also cleaned by the sand process and given a new lease of life, it having been demonstrated that a short exposure under the blast not only cleaned them, but considerably improved their sharpness at the same time. This will remind our older readers of the device in vogue years ago, which was used for the exclusive purpose of sharpening old files. Steam was used instead of air to force the sand against the files as an abrasive. These old machines are not used very extensively at this time, but they may still be seen about old shops.

The sand blast machine is also used at Topeka for sanding the ends of cars immediately after they are painted, as shown in Fig. 4. This work is very rapid, and the sand is put on to prevent injury of the paint of baggage and express cars that are placed next the engine and exposed to the cutting of cinders.

The Chicago & Northwestern Railway is also using the sand blast, and a frame building has been erected for cleaning tanks at the Chicago shops. The building is of such a size to conveniently take in one tank. Under the floor, which is of an open construction, is the sand supply, and this is elevated by compressed air to a storage reservoir which is located on the roof. Extending down from the reservoir is a ¾-inch pipe, having on its lower end a T, one end of which is connected to the compressed air supply pipe, and the other to the hose that directs the blast against the tender. The construction of the T is such that the entrance of the nozzle from the air supply passes by the opening of the pipe from the reservoir, and thus has an ejector action on the sand after the latter reaches the T by gravity. The arrangement is said to work very nicely.

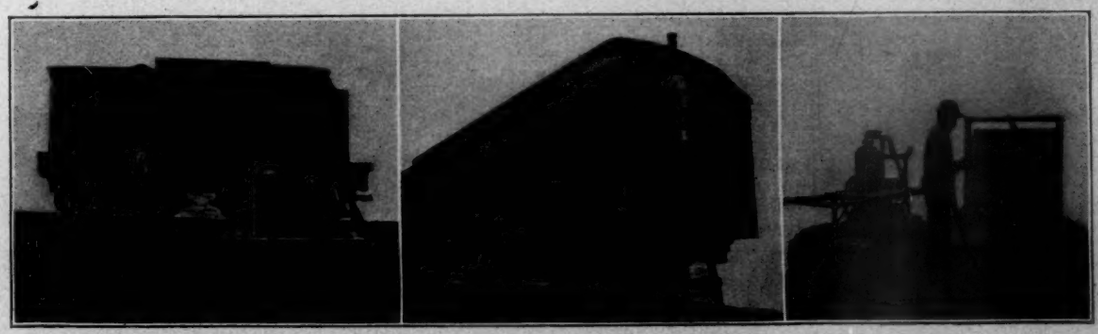


Fig. 2. Fig. 4. Fig. 3.

Three Applications of Sand Blast Apparatus.

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The reduction of unnecessary weight of locomotive parts is now most carefully studied, and it does not seem possible that much more may be done in this direction, but the spring rigging so far has not had a great deal of attention. It is possible that a material saving may be made in these parts, especially if coil springs with satisfactory "dampening" devices may be devised and used. It is open to question whether the heavy driving springs, spring hangers, equalizers and equalizer stands are indispensable, and the whole subject of equalization is worth investigation. With fast passenger engines the weight to be saved by coil springs would be very valuable in the boiler, and it is important to know whether the equalizers have time to act at high speeds, and whether the lack of equalization at low speeds is as important as has been believed.

The paper on friction of locomotive slide valves read by J. A. F. Aspinall before the British Institution of Civil Engineers, extracts from which we give in this issue, is one of the most valuable and interesting contributions to locomotive literature, for the very good reason that the data from which the coefficients were derived are the result of accurate and painstaking work. Additional evidence is offered disproving some old fallacies concerning the effect of port opening below the valve, on the force required to move it, and there will be less conjecture about the reactionary effect of steam under the valve than formerly. The tabulated results showing the coefficients of friction for balanced and unbalanced valves, and also the effect of lubrication, are worthy of preservation.

It has been known for some time that if the pressure within the cavity of a valve was relieved the size of the hole did not matter, but the real question concerning the balancing of valves was not reached by Mr. Aspinall, viz., the amount and distribution of the pressure exerted under the valve by the film of steam that permeates between the surface of the valve and that of the valve seat. This subject was investigated partially by Professor Robinson a number of years ago, but no data are available applying to present conditions. Our attention was recently called to the fact that on compound locomotives the amount of balance of the high-pressure valve cannot be allowed to be as large as that of the low pressure, and there is good reason to believe that a film of steam exerts an upward pressure for some distance from the edges of the valve. In the case of the high-pressure valve this effect is produced at the inside edges as well as the outside, and what we need most to know is the law governing this action. It has been suggested that the same experiment should be undertaken with flat plates, one of which is drilled to the atmosphere instead of using actual valves.

The New York Board of Railroad Commissioners have recommended legislation requiring a third man to be employed upon locomotives which are so designed, as in the case of the Wootten type, that the engineer and fireman are separated in such a way as to endanger the train in case of accident to, or the death of the engineer. The case arises as a result of several accidents which, while not involving death or injury to passengers, have possibly been narrow escapes. The question, as we see it, is whether a third man would really help the situation in the least. He would interfere with the engineer's duties, if riding on the right hand side of the cab, and on the left hand side he would not be likely to discover an accident to the engineer before the fireman would have his attention drawn to it by unusual speed or omission to give or answer signals. There is good reason to believe that the fireman, who must of necessity be on the alert for all changes in the manner of working the engine, would be the first to know of an accident to the runner, and it is difficult to see how anything better can be done than to provide good methods of communication between the two men, and it can usually be made possible for the fireman to see the runner without going forward. An extra man on a locomotive, especially if not kept constantly em-

ployed, is a source of danger, and so far as we can learn, the engineers themselves object to the proposed rule. A delegation of about thirty of them recently waited upon Governor Roosevelt, and protested against it on the ground that there would be greater danger with two engineers than with one. Human nature was human nature the world over, and it would show itself in the cab of an engine as quickly as anywhere else. The inclination to talk and visit would be given way to and one of these little visits would some day cause a horrible accident.

The desirability of giving more attention to the maintenance of brake equipment has been urged in these columns, and if further support is necessary, we have it in the record of the system of the Lake Shore and Michigan Southern Railway, presented elsewhere in this issue. The results of systematic inspection of this apparatus are convincing as to its value. We desire to remark especially on the fact that this inspection shows that cars from foreign roads that have just been given general repairs, even to painting and stenciling, at their home shops, are found with triples and cylinders in such bad condition as to need immediate overhauling and cleaning. This indicates a tendency to consider that devices which are known as automatic do not require careful attention. The Lake Shore experience also supports our position in recommending more care of present air brake equipment before advocating additional complications to take care of heavy cars.

POWERFUL LOCOMOTIVES.

Mr. Henderson's communication on fast passenger locomotives, in this issue, emphasizes some of the factors that we have been urging in the production of these engines, and his opinion of piston valves, large port openings and boiler capacity is worth pondering over. It is impossible to predict at this time to what this discussion will lead. It involves the entire locomotive, boiler, cylinders and valve motion, and a free discussion of how to make locomotives more powerful per unit of weight is worthy of the best thought and study. Greater efforts than ever before put forth in this direction are now being made by three trunk railroads of this country, which is an indication of a disposition to secure the desired result. The problem involves every type of locomotive, and from figures of improvement in fuel economy which we have seen, but cannot at this time make public, as a result of these efforts, it is made clear that railroad managements will find it to their advantage to so relieve motive power officers of the care of details which ought to be attended to by subordinates that they can devote their best attention to the locomotives and the fuel accounts. The questions which are suggested by Professor Smart and Mr. Vauclain, which were commented upon in our February issue, are understood by very few men, as inquiries among and conversations with prominent motive power officers show.

If the discussion discloses nothing else, that which has already been said concerning the port openings of valves and the provision of ample boilers is enough to keep designers busy for some time. Incidentally an opinion on the valve question may be worth mentioning. It is desirable to balance valves on account of relieving the friction and lost work of operation, but it is probably much more important to prevent the valves from lagging in their movements, due to the resistance of the valves on their seats, which causes the connections to spring and yield, with the result that the intended port openings are not obtained. It does not seem to be enough that steam ports be enlarged, unless the balancing of the valves is also improved. The piston valve is looked upon to obviate these difficulties, but even with this type the lagging of the valves is not always overcome, unless the packing rings are made in such a way as to avoid excessive friction against the casing. We shall probably print some observations on this question soon.

There is no indication of just what type the locomotive of the future is to be, but we look for large boilers, free steam passages, large port openings, balanced valves which will give the intended openings and compounding as important factors. It will not be surprising if four cylinders, separate steam and exhaust passages and separate valves, and even crank axles, are involved. If the advantages to be gained by their use are large enough, all of these will be accepted. Some remarks on the success of four-cylinder compounds in France, which we shall print in a future issue, are of interest in this connection.

THE M. C. B. COUPLER.

At the invitation of Mr. A. E. Welby, General Superintendent of the Rio Grande Western, to Mr. John Hickey, General Master Mechanic of the same road, to express himself with respect to the efficiency of the M. C. B. couplers, the latter gentleman took occasion to criticise the weaknesses of that form of coupler in his terse and emphatic style. There were few defective features of the coupler to escape notice. The expense of maintenance and application, as well as the uncertainty of security and the disappointment in experience with it, were referred to, and the lack of uniformity in the contour lines of the several makers, and also the wear on the locking devices received attention.

Several years have passed since this form of coupler was adopted by the M. C. B. Association and the weakness now so well known existed in the first of them, which indicates a slow if any movement toward improvement. The fact that there is a standard contour for the knuckle does not seem to be recognized by some makers, notwithstanding that there is room for improvement badly needed in the contact faces, which are a reproach as they stand. We are not of those who decry the M. C. B. coupler, for it is a great stride in advance of the link and pin, but it is far from perfect, and since it has become the standard of the railroads, there seems to be but one rational thing to be done with it—make it as near right as possible. Mr. Hickey's letter should have just that effect, or at least cause renewed efforts in that direction.

Such action will be forced on railroads as a measure of self-protection and not by legislation, through the necessity for something like uniformity in knuckles, and that simply means a standard. This was well shown by Mr. P. H. Peck in his paper on "The Adoption of a Standard Knuckle" before the Western Railway Club, in October, 1898. Out of a total of 77 draw bars nine of the bars had two and two bars had three knuckles each, and in only two of these bars would the knuckles interchange with each other. The effect of this condition of things on the finances of a railroad company is given by citing the requirements of one case for maintenance. There must be in way cars or at interchange points one of each kind of knuckle, averaging 48 pounds, or 4,464 pounds, which at 3½ cents would cost $156.24. To furnish one knuckle of each of the above kinds at sixteen different points and on twenty way cars puts the cost up to $5,624.64. This is a large price to pay for a chaotic and discreditable state of things.

Changing the point of view from that of the pecuniary advantages to be derived by an improved knuckle to the broader one of safety to life and limb, we find that, while there is a most gratifying reduction in the loss of life and mutilation of trainmen since the introduction of the automatic coupler, the murderous work still goes on. In the annual report of the Interstate Commerce Commission the compilation of the casualties to employees for the year ended June 30, 1897, made by the statistician of the Commission, is referred to by the latter as follows: "Since the enactment of the law, in 1893, there has been a decreasing number of casualties. There were 1,034 fewer employes killed and 4,062 fewer injured during the year ended Jan. 30, 1897, than during the year ended Jan. 30, 1893. In the Spanish-American war 298 men were killed, 1,645 were wounded. In 1897 there were 1,693 men killed and 27,667 injured from all causes in railway service. In coupling and uncoupling cars alone 219 fewer men were killed and 4,994 fewer men were injured in 1897 than in 1893. The number of such

employees killed has been reduced one-half, and the number of injured also practically reduced one-half. The reduction in the number of accidents from all causes largely exceeded in a single year the entire casualties during the late war."

The Commission has cause to congratulate itself on the fact that it has been instrumental in causing the removal of one cause of loss of life among trainmen, but there is reason to believe, from their own showing, that the work is not yet complete. Observation on the road and in the yard would convince the most inexperienced that many automatic couplers reverse their functions and are automatic only in uncoupling, which is certainly not the intent of their sponsors. There is no doubt that the greater portion of the casualties in coupling are due to the failure to couple and uncouple, and thus make it necessary for trainmen to go between the cars or hang to the hand holds, and thus risk their lives to perform manually what the coupler is supposed to do automatically.

The Western Railway Club has taken up a difficu.t but promising work by appointing a committee to investigate the coupler question thoroughly, for the purpose of making recommendations with a view of removing some of the greatest of the present difficulties, and information is now being gathered. The first thing to turn up is the great number of break-in-twos of trains, for most of which the couplers are probably responsible. One road of 2,500 miles has an average of 18 of these per day. The trouble has many causes, and the first step toward improvement is to obtain accurate and intelligent records of how the breaks occur. Comparatively few roads keep these records, and the committee urges the importance of the information. The length of the guard arm is another branch of the subject that needs attention, and this committee is trying to point out other directions in which a general improvement may be made both in form and in character of material to be used. The best recommendations they can make will be a series of specifications and tests not only of the material, but the form and methods of locking the knuckles positively. This will be very difficult to arrange, and yet the most discouraging element in the whole situation is the tendency for railroads to take the penny-wise view. Mr. John Mackenzie said before one of the railroad clubs recently that if a railroad management could buy a coupler for 50 cents less than the cost of other couplers, that is the one they want without regard to the lines or material employed. This attitude has had much to do with the present chaotic condition, and if continued, it will defeat every effort toward improvement. Even this, however, may be overcome by specifications and tests that are so rigid as to weed out inferiority.

AUTOMATIC BRAKE SLACK ADJUSTMENT.

The niceties of airbrake operation are observed by the railroad man as one of the first things to attract his attention, and the traveling public is also becoming so well informed on the subject of what constitutes good use of brakes that one may hear the character of stops discussed on any passenger train, by men who do not know the first principles on which the brake does its work, but are well informed as to what a good stop is. The necessity for smooth operation on freight trains is not so apparent from a physical point of view, but there are financial considerations that demand it in either case, and an adjustment of the parts to overcome wear is naturally the first thing to suggest itself to keep the brake up to its best efficiency, that is, to reduce wheel sliding by uniform distribution of braking power. This is best accomplished by means of an automatic device, which, it is obvious, is preferable to hand adjustment because of the accuracy of its results, and for the reason that it does its work best while the train is in motion. On long runs, where the wear of brake shoes make slack adjustment an absolute necessity, the work cannot be done satisfactorily by hand for want of time, as has been demonstrated too many times. A peculiarity of an adjuster that really adjusts is that it will wear out more brake shoes than one unable by functional weakness to perform its duties.

This was seen on the New York, New Haven and Hartford, when it was found necessary to reshoe an entire train each day, whereas, prior to the application of the adjuster, the train was reshod once a week. A three months' record of the same adjuster, but on another road, gave the flattering report of no flat wheels, but the opposite trains on the same run, which were not equipped with the adjuster, had forty-two flat spots reported against them in the same time. Here, evidently, the adjuster was making each car and each wheel do its full share of braking. On the transcontinental lines all the condition for a fair and impartial test of the merits of a brake slack adjuster are found, and where so tested the fittest is the only one to survive. It is the practice on the Great Northern to properly adjust the piston travel on all cars before leaving St. Paul. In making the 1,700 miles between St. Paul and Seattle the piston travel increases, in some cases, two inches. With the slack adjuster there is no adjustment needed on arrival at Seattle, and the trains return to St. Paul with the same piston travel they had on leaving that terminal. This very fine performance, as we happen to know, is an every day occurrence on that road and has been going on for several years. Fairness prompts us to say that the device we refer to is the McKee brake adjuster.

Opinions on the general subject of brake adjusters are expressed elsewhere in this issue in connection with the subject of airbrakes as applied to heavy cars. We do not believe that they are less necessary on ordinary cars, and if in certain cases they have failed to give satisfactory results it will probably be found that the relatively small amount of attention required by all such devices has not been given.

NOTES.

A wrecking train under way in seven minutes from the sounding of the alarm is the record of the Wabash at Decatur, Ill., January 25, 1899. Our informant states this was a real record and made in the course of ordinary work, the occasion being impossible for the officers or men to foresee.

Wireless telegraphy is to be tried by Signor Marconi at the South Foreland Lighthouse and on board the South Goodwin lightship, says "Engineering." If the experiment is successful the system will be adopted as a means of communication between the South Foreland Lighthouse and the South Sands Head lightship, a distance of about 3 miles.

An arrangement of separate exhaust valves of the piston type has been designed by Mr. J. A. F. Aspinall of the Lancashire & Yorkshire Railway, England. It is referred to by "The Engineer" as very satisfactory in reducing the back pressure but we should expect to find its greatest advantage to be in separate exhaust ports whereby the use of the present steam passages alternately for live and exhaust steam may be avoided.

A new speed record has been established for cruisers by the newly completed Japanese cruiser "Chitose," built by the Union Iron Works and given her official trial February 12. Mr. Irving M. Scott is quoted as saying that the average speed for 2 hours 45 minutes was 22.87 knots, and this without an accident of any description. The highest and lowest speeds were 23.76 and 22.3 knots, respectively. The "Chitose" is a protected cruiser of 4,760 tons, 402 feet 2 inches in length, and drawing 17½ feet of water. She has triple expansion engines, which are capable of developing 15,500 horse-power. Her armament will consist of two 8-inch and ten 4-inch rapid-fire guns, twelve 12-pounders, six 2½-pounders and five torpedo tubes.

Electric traction for the Manhattan Elevated has been promised for a long time, but it now seems to be assured, because of the issue of $18,000,000 in bonds, just authorized by the directors. The president, Mr. Gould, according to a published statement, has investigated the cost of electricity on the prominent lines using it, and he believes that the change will effect a reduction of 2½ cents per car mile in the expense of operation. On the present schedule this will amount to more than $1,000,000 per annum.

London city refuse used as fuel for electric lighting has been very successful at Shoreditch. The cost of disposing of the street refuse was formerly $30,000 per year, which included the collection and dumping at sea. The cost of gas for street lighting was $20,000 per year. The new electric plant cost $60,000, and the cost for the first year was $19,070 for labor, supplies, insurance, etc. The interest, rent, depreciation, etc., cost $10,205, making a total of $29,275. The gross receipts for the sale of power and light were $43,205, giving a net profit of $15,930.

Compound locomotives are making good records on the Chicago, Milwaukee & St. Paul Railway, where figures showing the relative coal consumption of simple and compound engines have been carefully kept for a number of years. A number of engines that are exactly alike, except as to the cylinders, gave an average advantage of 14 per cent. in fuel per 100 tons one mile, on the West La Crosse division, and of 16 per cent. on the East La Crosse division, the record covering an entire year.

The death of a locomotive engineer while running his train is reported to have occurred on the Lehigh Valley February 11. The case is somewhat similar to one on the Erie some months ago, when the runner is supposed to have met death by striking his head against an obstruction, and the accident was not discovered by the fireman until the speed of the train increased to an unusual extent. The engines are of the type in which the cab is over the boiler and the men are separated by a considerable distance.

A pleasing and profitable co-operation betweeen the people and the railroads of Massachusetts is made evident in the 1898 annual report of the railroad commissioners of that State. There were 36 independent companies operating railroads in that State in 1872, and the number has now been ruduced to 11. The report says: "The process of consolidation has been accompanied by the voluntary reduction, during the period named, of the average passenger fare from 2.43 to 1.78 cents per mile, and of the average freight rate from 2.81 to 1.22 cents per ton mile, and there has been, moreover, in the meantime, a marked improvement in the quality of the railroad service rendered."

A speed of 35.2 knots per hour is reported to have been made on a measured course of 18½ miles by the new torpedo boat destroyers built by Schichau, of Elbing, for the Imperial Chinese Navy. "Engineering" records the results, and states that a speed of 33.6 knots was made with 67 tons of coal on board, the full bunker capacity. The air pressure was from 1.58 to 1.77 inches of water, and the stokers are said to have had a comparatively easy time. The boats are 193½ feet long, 21 feet beam and of 280 tons displacement. The contract speed was 32 knots and the horse-power of the engines 6,000.

The success of the Boston subway is of special interest in connection with the proposition to construct an underground line in New York. It is often said that American people like to travel above ground too well to patronize a tunnel, but the experience in Boston shows that a good transportation scheme is popular, even if somewhat novel. "Engineering News" prints a comparison of traffic from Park Street, Boston, before and after the use of the subway, and shows an increase of 300 per cent. since December, 1894, whereas the normal increase in the surface traffic during that time would not have been more than 40 or 50 per cent. During the first year of the operation of the complete subway the number of passengers taking and leaving the cars at Park Street Station is expected to be at least as great as the number of passengers entering and leaving Boston by the steam railroad trains at the North Union Station, or about 24,000,000, and also greater than the aggregate number of passengers entering the city last year by all the other steam roads which are soon to occupy the South Union Station. An idea of the character of the traffic is given by the statement that at Park Street Station it is necessary to load cars for 27 different routes from five consecutive berths on one track.

A magnificent increase in net earnings has accompanied the change from steam to electric traction on the South Side Elevated Railroad (The "Alley L") of Chicago, as shown in the report for the year ending December 31, 1898. The figures for net earnings for the last two months of the year are as follows:

November,	1897, steam	$10,603
"	1898, electric	39,448
December,	1897, steam	14,691
"	1898, electric	45,355

The Sprague multiple unit system is in use, and these months of each year include the figures for the rental of the "Loop." The total trackage is 19.44 miles.

TESTS OF NICKEL STEEL.

Effect of Varying Proportions of Nickel.

Some interesting, though fragmentary, data from tests nickel steel are reported in "Engineering," the tests having been made at the Charlottenberg Testing Institution near Berlin. The chemical composition of the specimens used varied between 99.6 and 0.33 per cent. of iron, with 0.05 to 98.4 per cent. of nickel, the percentage of other ingredients, such as cobalt, copper, manganese, aluminum and sulphur being very small. The percentage of cobalt varied from 0.01 to 1.03 per cent,, it increasing with the percentage of nickel. The effect on the physical properties of varying proportions of nickel is indicated in the table:

Per cent. of nickel.	Limit of elasticity. Lbs. per sq in.	Tensile strength. Lbs. per sq. in.	Elongation, Per cent.
0	20,630	46,472	30
8	62,496	79,520	10
16	....	58,240	1
30	....	14,224	2
60 to 98.5	....	53,760 to 42,560	35 to 17

Increasing the proportion of nickel from 0 to 8 per cent. steadily increased the elastic limit and tensile strength, the greatest strength accompanying the largest amount of nickel. Increasing the nickel caused irregular results, as shown by the table. Porous fractures were obtained with 0.5 per cent. of nickel becoming close with 1 per cent. Three per cent. gave fractures of fine grain and proportion increasing above this made them coarser until needle-shaped crystals were finally obtained. An exception was found with 60 per cent. of nickel which gave normal strength and fine grain. The compression tests gave results similar to those in tension. Experiments in rolling showed that the process could not be used with more than 4 per cen' nickel and fractures occurred with higher percentages.

PURDUE UNIVERSITY.

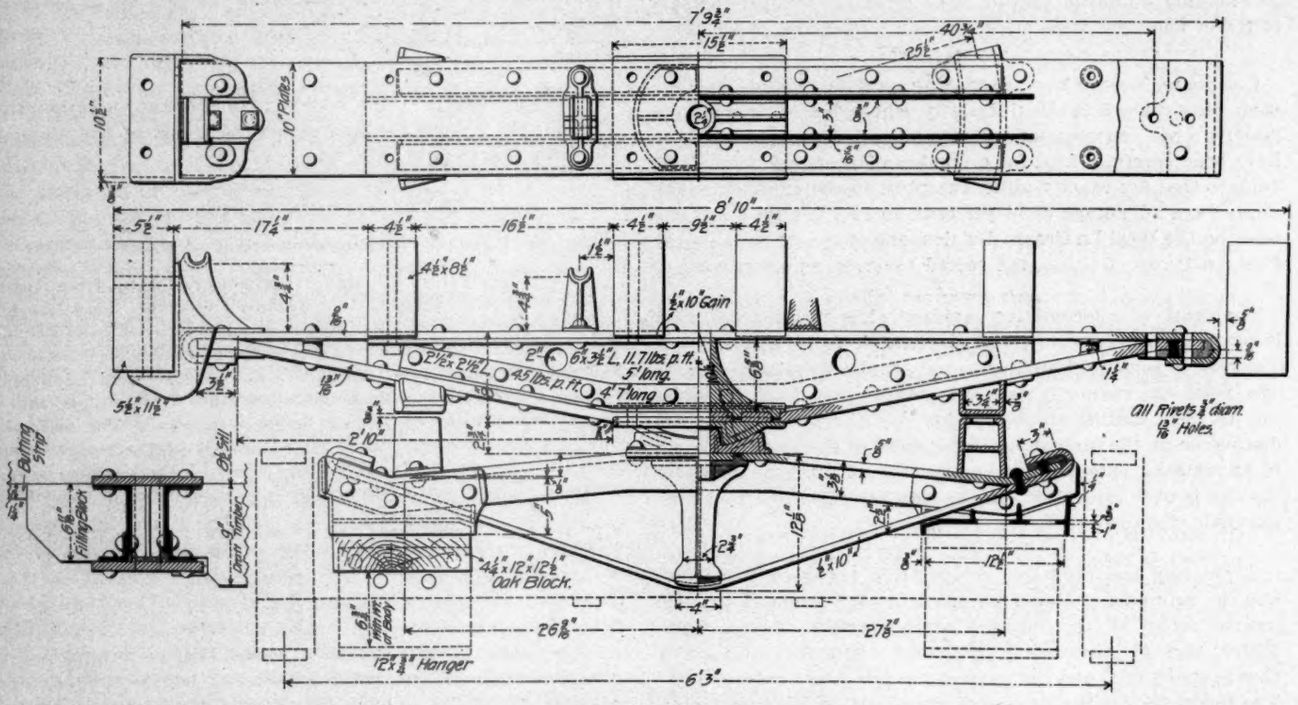
Mr. Robert S. Miller has been appointed Assistant Professor in charge of the Department of Machine Design, and Mr. L. V. Ludy has been made Assistant in the Engineering Laboratory, assuming the work which has hitherto been carried on by Mr. Miller.

Mr. Miller is a graduate of the School of Electrical Engineering, class of '95, and received the degree of Mechanical Engineer from the same institution in '97. Since graduating he has been assistant in the Engineering Laboratory, and later instructor in mechanical engineering. In addition to his routine work at Purdue he had a leading part in the exhaustive series of tests made two years ago at Purdue upon the balanced compound locomotive, and last year was in immediate charge of the fuel tests made at the University for the Big Four Road, and still more recently assisted in the duty test of the 20,000,000 gallon Snow pumping engine at Indianapolis, the results of which have attracted general attention.

SIMPLEX BODY AND TRUCK BOLSTERS.

Southern Railway.

The arrangement of simplex bolsters shown in our engraving is an adaptation to the requirements of the 60,000-lb. capacity gondola cars of the Southern Railway. They are designed to supplant 6 by 16-inch oak body bolsters, with two 1¼-inch truss rods, and 12 by 12-inch oak truck bolster, having two truss rods of 1-inch body and 1¼-inch ends. A contrast could hardly have been made more striking than by the selection of these two representatives of bolster practice—the one standing for advanced mechanical construction, and the other an example of a type doomed to be soon obsolete, but where still seen it serves to emphasize the fact that old standards are kept long after their usefulness has departed, although



Body and Truck Bolsters—Southern Railway.
The Simplex Railway Appliance Co.

the heavy capacity equipment has practically driven the wooden affairs out of commission.

A height of 8 inches is in this case allowable over the plates of the body bolster at the center, which gives an ample trussing effect in conjunction with the two ⅜ by 3½ by 6-inch angles, the long sides of which are placed vertically between the two bolster plates and extend to the outside face of the intermediate sills, being cut to fit at the lower edges. These angles are riveted through their short flanges to the upper plate of the bolster, while the long sides are in turn riveted to 2½ by 2½-inch angles that are riveted to the bottom bolster plates, a construction that is very stiff, as will be seen in the separate sectional detail.

The truck bolster consists simply of a 12-inch channel compression member and a ½ by 10-inch plate tension member, and is too well known to require a description, it having appeared in our October, 1898, issue in connection with its application to the tenders of the Chesapeake & Ohio new class G-6 consolidation engines. These bolsters are made by the Simplex Railway Appliance Company, Chicago, and are making rapid strides in both locomotive and car equipment in which stiffness, lightness and durability are the prime requisites.

VALUE OF GOOD STAYBOLT IRON.

To illustrate the actual saving effected by buying the best of boiler material we quote remarks by Mr. Higgins, Superintendent of Motive Power of the Lehigh Valley, in a discussion before the New York Railroad Club as follows: "We have had some experience with staybolt iron of various qualities. Up to four years ago the road I am with bought staybolt iron, or what was called staybolt iron, at a certain price. We then commenced ordering stay-bolt iron costing three times as much per pound as what we had been using. Previous to the change we ordered on an average twelve tons of staybolt iron per month. Since the change we have ordered on an average five tons of iron per month, and the longer we continue using the more expensive iron, the less the amount ordered each month. Or, in other words, some time had to elapse before we really commenced to feel the effect of having the better iron for staybolts in the boiler. This reduction in the amount of staybolt iron ordered has occurred, notwithstanding the fact that there has been quite a large increase in the number of engines owned by the road."

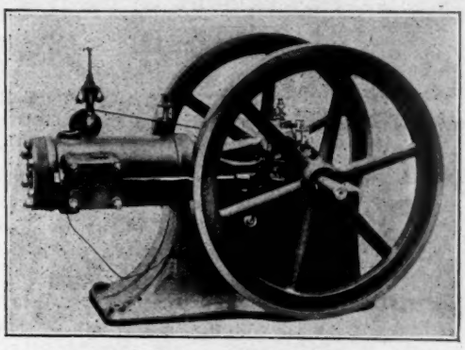
MAGNOLIA METAL COMPANY WINS PIRACY SUITS.

We learn with pleasure that the protracted law cases which have been pursued in England by the Magnolia Anti-Friction Metal Company, Limited, the London branch of the Magnolia Metal Company here, in defense of their rights to their celebrated brand, and their business, has been decided in their favor against John Sugdon, W. E. Watson, A. G. Brown, the Atlas Bronze Company, Limited, and the Atlas Metal Company, Limited, and others who were enjoined respecting patents and trademarks, and from engaging in any anti-friction metal business, with costs and damages. The text of the decision, as it appears in the English papers at hand, is very severe and sweeping. We congratulate the Magnolia Metal Company upon this result; the cases have been prosecuted with great vigor, and no doubt large expense, and it is of value to Americans registering under and appealing to English laws to know that they do and will protect when properly appealed to.

THE SUMNER GAS AND GASOLINE ENGINES.

The adaptability of gas and gasoline engines to the service of railroads for pumping and raising coal received comment in our February issue, and an appreciation of the advantages to be gained by their use will undoubtedly be followed by almost universal app'ication of these engines for such service.

The Sumner engine, made by the F. M. Watkins Co., of Cincinnati, Ohio, illustrated in the accompanying engraving, is the result of experiments and improvements covering 15 years, and it is now used in place of steam engines up to 25 horse power, the one shown being the 4 horse power size. The parts of the engine, particularly the bearing surfaces, are large, being designed with reference to long wear. Cheapness of first cost is not sought after at the expense of good, durable construction. The bearings are of phosphor bronze, and all parts are made on the interchangeable plan, which would not be possible with babbitted bearings. The crank shafts and connecting rods are forged from solid steel billets and the fly wheels, which



The Sumner Gas and Gasoline Engine.

are double for all but the 2 horse power engine, are very heavy. The best grade of iron is used in the castings, the base and cylinders being of very hard iron to insure long life.

One of the features for which much is claimed by the builders is the electric igniter, which makes use of a magneto machine, employed only in the Sumner engine. These are used with the expectation that they will last as long as the engine and effect a great saving over the batteries that are generally employed for obtaining the sparks for ignition. The magneto is advocated because of avoiding the cost of renewing and replacing batteries and tube igniters. It is clear that igniting devices that may be depended upon not to fail at critical times must be appreciated, and uncertainty in this regard has undoubtedly exerted an influence in retarding the introduction of internal combustion engines. These builders guarantee the igniting devices to work satisfactorily for two years, and some are now running in good order after five years of continuous service, and show no signs of deterioration. The magneto generator is very simple. Its commutators are in the form of hardened steel rings with self adjusting brushes of softer material. The armature is incased in a brass box, which may be seen between the spokes of the fly wheel in the engraving. The armature is geared to the main shaft, and current for starting the engine is generated by turning the fly wheel slowly by hand for the first ignition. The spark is produced in a special ignition cavity away from oil and where the gas is richest, to insure regular and economical ignition. The spark is produced by bringing the electrodes together slowly and suddenly separating them in such a way as to avoid wearing and battering the electrodes. The condition of the contact points may be observed at any time while the engine is running, and they may also be cleaned without stopping or interfering with the operation of the engine. The makers claim simplicity, reliability and durability for the igniter, and also that it lights every charge, does not deteriorate or burn out and is permanent.

When using gasoline—ordinary stove gasoline is used—the supply is pumped from a safety tank placed under ground and outside of the building. It is so arranged that any surplus raised by the pump and not needed in the cylinder returns automatically to the tank. The supply pump has no stuffing box, and as the valves are always sealed by gasoline, it does not require priming. The gasoline is supplied in the form of an atomized spray, which is mixed thoroughly with the proper amount of air so that the ignition is complete at the dead point. The gas mixer balances the gas pressure in such a way as to dispense with check valves. The gas and air valves are combined in one, which is applicable to natural or artificial gas, and the builders state that this mixer makes it possible to start the engine with certainty on the second turn of the fly wheel. The governor regulates the pressure in the cylinder in proportion to the work to be done, and permits of obtaining an explosion for each alternate revolution. The makers say that it gives a regulation within 1 per cent., permitting of running electric light generators direct from the driving pulley.

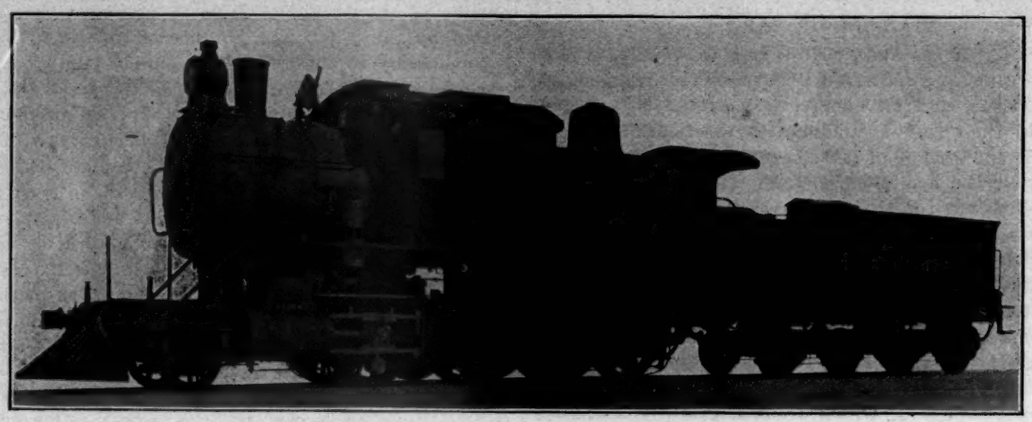
The ease of starting is a special claim for the Sumner engine, and on large sizes automatic starting devices are used whereby the time for starting is reduced to 30 seconds.

TONNAGE RATING ON THE CANADIAN PACIFIC.

An accurate rating by tons of the hauling capacity of locomotives has for some time been understood as one of the most vital elements in the transportation problem, but it is only very recently that systematic effort has been made to reap the benefits of minimum loading. The apathy existing in some quarters is perhaps explainable by the fact that undue importance has been given to the supposed magnitude of the undertaking of the establishment of a rational system to fit individual conditions. Among the later roads to adopt a plan of this kind is the Canadian Pacific, which has evolved a system of its own, embracing a rating for each locomotive on the road, and in each direction for a given district. This rating applies to 673 engines and includes twelve classifications for freight service.

The fundamental feature of this system is to give each class of engine a rating equal to a given percentage of an established standard. This percentage covers a range from 143 per cent. down to 60 per cent. The trains are embraced under the two heads of ordinary freights and fast freights, and with the ordinary freights as a base, there is a deduction made for ordinary and bad rail conditions, and also for temperature from zero to 32 degrees plus, from zero to 20 degrees minus, and for a temperature colder than 20 degrees minus. As showing the elasticity of this scheme, the Superintendents may, in special cases not provided for by the rules, authorize a special rating, and in addition to this the hauling rating of locomotives in wind or snow storms will be governed at the time according to conditions.

Tabulated values of the tonnage capacity of each class of engine simplifies the system for the use of those making up the trains, and reduces the work of assigning tonnage down to a few calculations in order to find the proper load. There has always been considerable diversity of opinion as to what should be the allowable weight for empties of all kinds. Five tons is allowed in this tonnage system for each empty freight car, in addition to the tare of the car. An exception to this is noted in case of long palace horse cars and refrigerator cars. A similar reduction is made in the capacity of an engine moving with the tender ahead, and also with double-head or pushing engines. To remove all doubt as to what allowance to make for equipment on which the tare weight is unknown, a table of estimated weights is furnished, which includes every type of car on the road, which is an evidence of care to leave no element of doubt or any chance for misconstruction. In fact, the whole system appears to be framed with the one purpose in view of having it plain enough to be understood and used. It is in operation on the Ontario and Quebec division under the supervision of General Manager Thomas Tait, with results of the most satisfactory character.



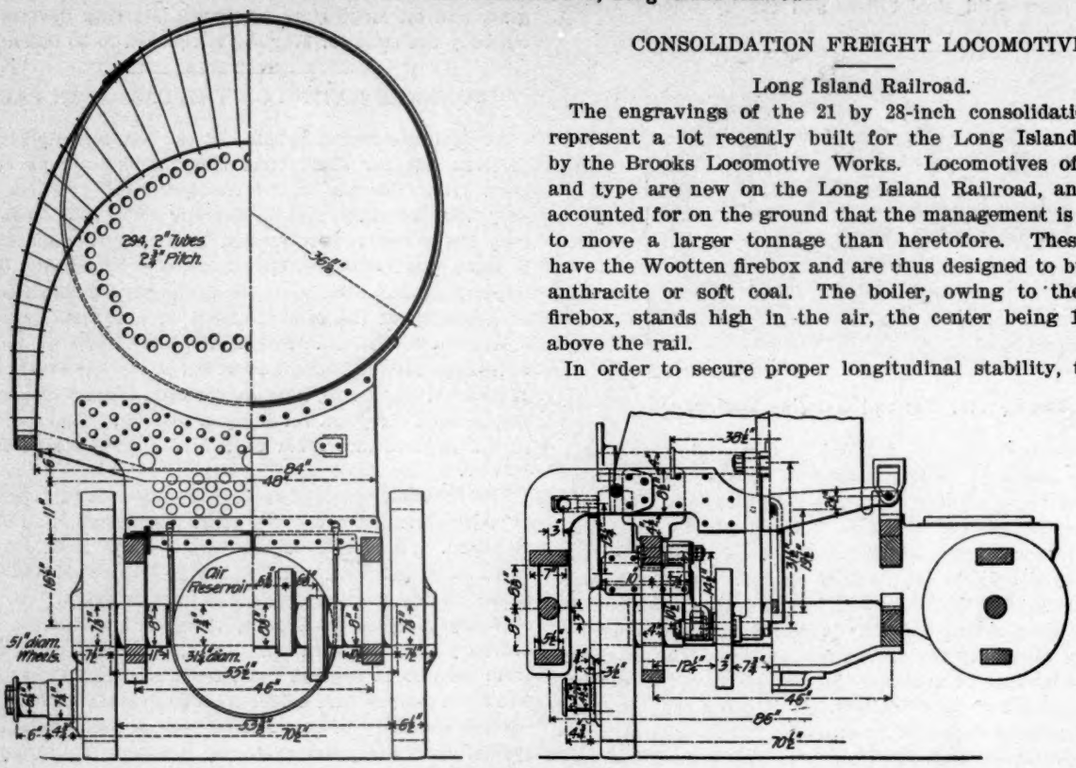
The New Consolidation Locomotive, Long Island Railroad.

CONSOLIDATION FREIGHT LOCOMOTIVE.

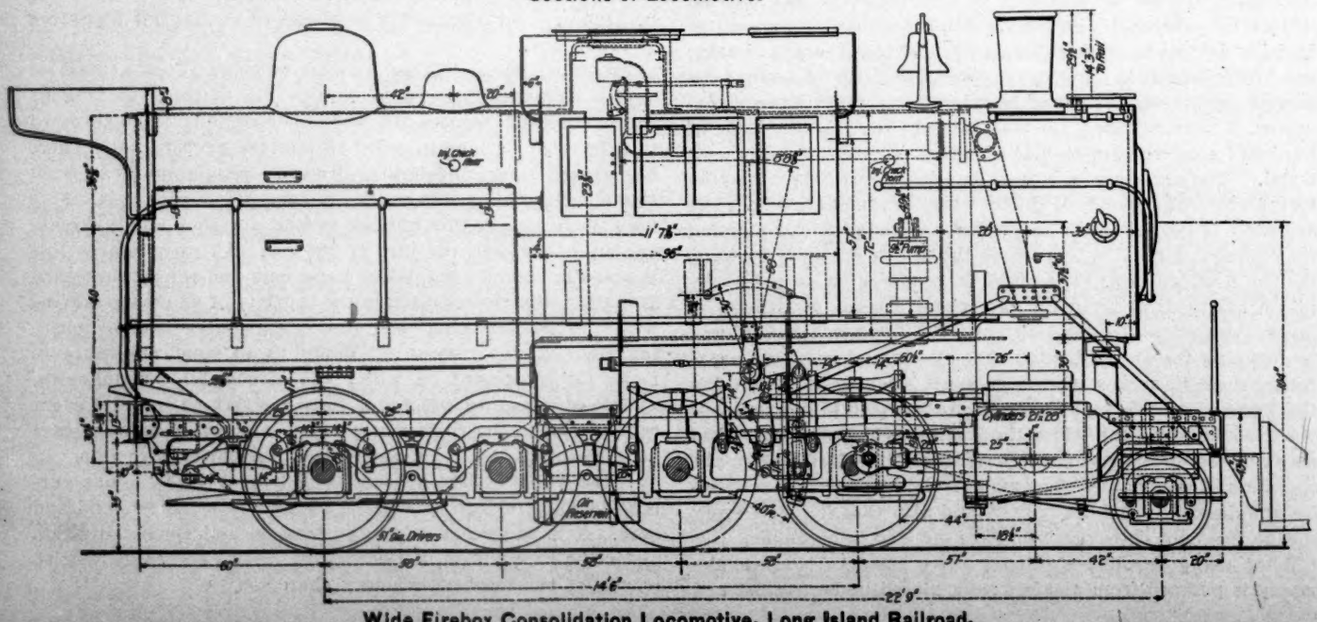
Long Island Railroad.

The engravings of the 21 by 28-inch consolidation engine represent a lot recently built for the Long Island Railroad by the Brooks Locomotive Works. Locomotives of this size and type are new on the Long Island Railroad, and may be accounted for on the ground that the management is preparing to move a larger tonnage than heretofore. These engines have the Wootten firebox and are thus designed to burn either anthracite or soft coal. The boiler, owing to the style of firebox, stands high in the air, the center being 104 inches above the rail.

In order to secure proper longitudinal stability, there is a



Sections of Locomotive.



Wide Firebox Consolidation Locomotive, Long Island Railroad.

MR. S. F. PRINCE, JR., *Supt. Motive Power.* BROOKS LOCOMOTIVE WORKS, *Builders.*

double brace at the smokebox, having a central foot common to both braces, this foot being riveted to the smokebox just above the junction of the latter with the cylinder saddle. These braces extend front and back, the former going forward to the front of frame and the latter back to the guide yoke. This construction presents an odd appearance at this time because we have gradually outgrown the idea of the necessity for front end braces in the last few years, but there is no question of the value of these braces in relieving the saddle bolts of a considerable tendency to shearing.

An example of the certain passing of the extension front is to be noted on these engines; the fronts are fitted with the improved Bell spark arrester, and are only long enough to take in the cinder hopper, while the length is sufficient to admit the headlight in front of the stack, the lampboard being flush with the door ring. The construction of the reverse shaft is with one central lifting arm for the two link hangers. It is peculiar to the Brooks Works and a good plan. A safe stowage place for the main air reservoir is seen to be between the frames at the rear of the main drivers; the reservoir is slung by two stirrups that are secured to a casting resting on the frames. The use of the Wootten firebox on the Long Island is the result of the policy of the company to reduce the smoke nuisance as far as possible, and to that end locomotives recently overhauled have been fitted with this firebox. These engines have fireboxes 7 by 10 feet, and a total heating surface of 1,952 square feet. Our engravings show the general appearance and many of the detail dimensions of the engines.

On a dry rail they will exert a draw bar effort of 35,000 pounds. They are cylindered up to their adhesive weight, or, in other words, they do not carry any superfluous load on their drivers with the expectation of some day meeting with a slippery rail. This will be seen by the coefficient of adhesion of 0.261. It is notable, by the way, that the latest designs of heavy locomotives show a tendency toward a high coefficient, it being understood that the sanding devices can take care of an occasional adverse condition of rail. A description of these engines will be found below:

General Description.

Kind of fuel to be used	Anthracite and soft coal
Weight on drivers	135,000 pounds
" " trucks	20,000 pounds
" total	155,000 pounds
" tender, loaded	86,000 pounds

Dimensions.

Wheel base, total, of engine	32 feet 9 inches
" " driving	14 feet 6 inches
" " total, engine and tender	49 feet 6 inches
Length over all, engine	35 feet
" " " total, engine and tender	60 feet ¾ inch
Height, center of boiler above rails	8 feet 8 inches
" of stack above rails	14 feet 3½ inches
Heating surface, firebox	179 square feet
" " tubes	1,773 square feet
" " total	1,953 square feet
Grate area	69 square feet

Wheels and Journals.

Drivers, diameter	51 inches
" material of centers	Cast steel
Truck wheels, diameter	30 inches
Journals, driving axle	8 by 10 inches
" truck	5½ by 10 inches
Main crank pin, size	6¼ by 6 inches

Cylinders.

Cylinders, diameter	21 by 28 inches
Piston rod, diameter	4 inches
Main rod, length center to center	120 inches
Steam ports, length	18 inches
" " width	1⅝ inches
Exhaust " length	18 inches
" " width	3 inches
Bridge, width	1½ inches

Valves.

Valves, kind	Richardson balanced
" greatest travel	6¼ inches
" outside lap	¾ inch
" inside "	None
Lead in full gear	None

Boiler.

Boiler, type	Straight top
" working steam pressure	180 pounds
" thickness of material in barrel	11-16 inch
" " " tube sheet	½ inch
" diameter of barrel	72 inches
Crown sheet, stayed with	Radial stays
Dome, diameter	30 inches

Firebox.

Firebox, type	Wootten over wheels
" length	120 inches
" width	84 inches
" depth, front	64 inches
" " back	58 inches
" material	Steel
" thickness of sheets—	Tube, ½ inch; sides, top and back ⅜ inch
" Brick arch	None
" mud ring, width—	Back, 3½ inches; sides, 3½ inches; front, 4 inches
Grates	Cast-iron shaking
Tubes, number	294
" material	Charcoal iron
" outside diameter	2 inches
" thickness	No. 11 B. W. G.
" length over tube sheets	11 feet 7 3-16 inches

Smokebox.

Smokebox, diameter, outside	75 inches
" length from flue sheet	63 inches

Other Parts.

Exhaust nozzle	Single
" " diameter	5 inches; 5 3-16 inches; 5⅜ inches
" " distance of tip above center of boiler	1 inch
Netting, wire or plate	Wire
" size of mesh or perforation—	2½ by 2½ inches, and 2¼ by 1¼ inches
Stack, straight or taper	Steel taper
" least diameter	15⅞ inches
" greatest "	18⅞ inches
" height above smokebox	30 inches

Tender.

Type	8-wheel, steel frame
Tank capacity for water	4,000 gallons
" " " coal	8 tons
" material	Steel
" thickness of sheets	3-16 inch and ¼ inch
Type of underframe	Steel channel
" " springs	Half elliptic
Diameter of wheels	33 inches
" and length of journals	4¼ by 8 inches
Distance between centers of journals	5 feet 4 inches
Diameter of wheel fit on axle	5⅜ inches
" " center of axle	4¾ inches
Length of tender over bumper beams	23 feet 6 inches
" " tank	20 feet
Width " "	8 feet 7 inches
Height " " not including collar	52 inches

Special Equipment.

Brakes	American for drivers; Westinghouse for tender and train service.
Pump	9½ inches
Sight feed lubricators	Detroit
Safety valves	Prince
Injectors	Sellers
Springs	French
Spark arresters	Bell's improved

STREET CAR BRAKES.

What would appear to be an excellent opening for the exercise of the inventive faculty is to be found in the want of a satisfactory braking system on street cars. The old crude devices used on horse cars is doing duty on electric cars, and while they were never good, they are now simply a reproach to those responsible for their use at this day, when a good brake is as much of a necessity in crowded street traffic as on a steam road. The numerous cripplings and deaths resulting from the failure to provide a suitable brake have aroused the New York State Railroad Commission to action in the matter, and they have invited all those interested in power brakes to assist at a test of such brakes in New York city on the tracks of the Metropolitan Street Railway Company. The excuse for the continuance of the old hand-brake, namely, that no satisfactory power brake had ever been devised, will not satisfy the present inquiry, and we may now expect to see some improvement. Brake shoes should come in for a share of attention in this test, as they are exceedingly important in influencing the quickness of stops.

WATER IMPURITIES.

The Master Mechanics' Association Committee on "Best Method of Preventing Trouble in Boilers from Water Impurities" is seeking information on the above subject for presentation before the convention next June. The information asked for in the circular of inquiry is confined strictly to the troubles that occur from impure water; what has been done to overcome such trouble; the cost per thousand miles for purification; the cost for same mileage for boiler washing; how the cost of washing has been affected by the use of purifiers, and to what extent; the average life of flues and fireboxes, and instructions to engineers and roundhouse men in connection with the use of water-purifying methods. The committee is composed of Messrs. A. E. Manchester of the Milwaukee, J. H. Manning of the Union Pacific, S. P. Bush of the Pan Handle, Henry Bartlett of the Boston & Albany, and R. M. Galbraith of the St. Louis Southwestern, representing experience covering all parts of the country and presumably every kind of water used in the United States. It will be noted that the information desired does not have to do with the chemistry of the subject, but is purely mechanical.

FRICTION OF LOCOMOTIVE SLIDE VALVES.

Experiments upon the friction of locomotive slide valves conducted upon a locomotive on the Great Southern & Western Railway were described in a paper by Mr. J. A. F. Aspinall before the Institution of Civil Engineers (England) in 1889, and the information then given has been recently supplemented by another paper by him before the same organization. The experiments were tried with valves resting against a vertical face, on an inside-cylinder engine, the steam chest being between the cylinders. The author considered it possible that the friction of slide valves when resting upon a horizontal face might be somewhat different from that of valves resting upon a vertical face, and he also desired to test the advantages to be obtained from partial balancing. The following experiments were therefore carried out upon a Lancashire & Yorkshire Railway engine at Horwich, the engine being fitted with the Joy valve gear, Fig. 1. The recording apparatus was similar to that used in the experiments of 1889. Every

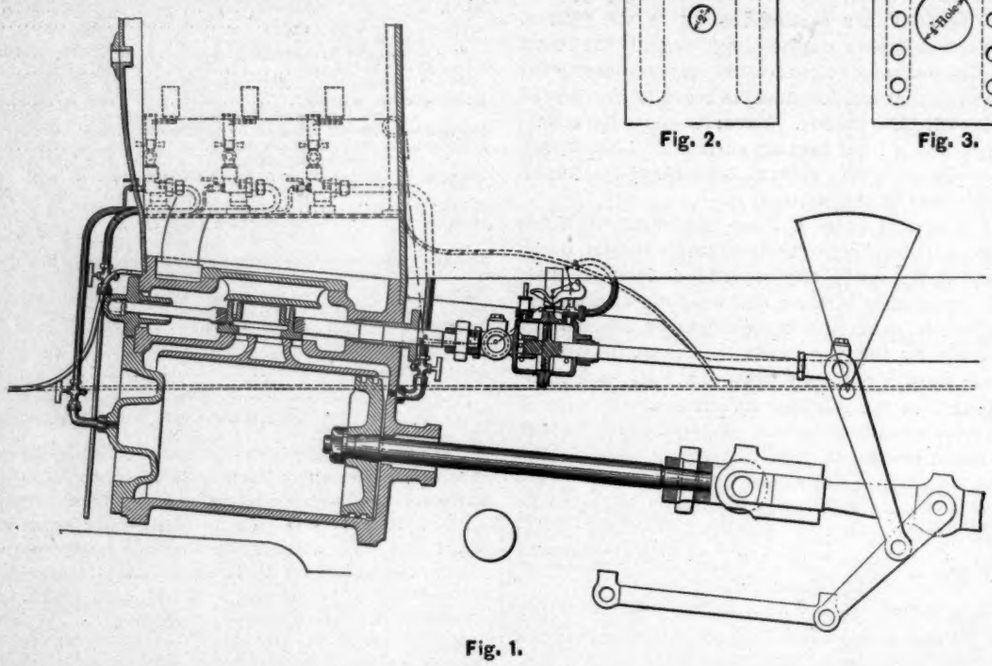


Fig. 1.

care was taken to calibrate the apparatus beforehand, and to ascertain the limits of error which could be allowed for in the final experiments.

In the 1889 experiments, the indicator diagrams, which were taken to show the work done in the engine cylinder at the same moment that the friction diagrams were taken from the dynamometer, were of the ordinary length, the motion being obtained by suitable mechanism from the piston crosshead; but in the present experiments the motion was obtained from the valve-spindle crosshead, this being considered a more accurate method of ascertaining the steam-pressure at any known position of the valve. It thus became easy to obtain a simultaneous record giving a friction diagram, a steam chest diagram and a steam cylinder diagram, thus eliminating any error that might have been present had these diagrams been taken one after the other.

The speeds at which the diagrams were taken varied between six and eight miles an hour. Two kinds of valves were experimented with; one, an ordinary D valve made of phosphor-bronze; and the other of the Richardson type, made of cast iron, with an open back; the fixed plate against which the valve slides being also of cast iron. The annexed table gives the leading particulars of the steam pressures and other points of importance; the coefficient of friction in each case being given in the last column. Thirty-one sets of diagrams were taken with the D phosphor-bronze valve, the average coefficient of friction being 0.0878, and six diagrams were taken of the cast-iron Richardson valve, the average coefficient of friction being 0.0919. In the partially balanced valve, the balance area was taken as being that portion which is enclosed between the strips, excluding the area of the strips themselves.

The good results obtained with the Richardson valves have caused the author to modify the views he previously expressed as to the advantages to be obtained from balancing. The experiments show that the friction of slide valves is somewhat greater against a horizontal than against a vertical face; the coefficient of friction found in the 1889 experiments for valves on a vertical face was 0.068, while in the experiments

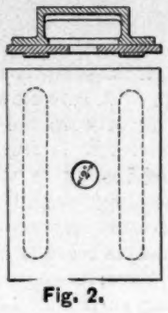


Fig. 2.

Fig. 3.

dealt with in the present paper the average coefficient was found to be for the unbalanced valve 0.0878, and for the partially balanced valve 0.0919. There is a considerable advantage in having to overcome a force of only 854.3 pounds for the balanced, as against a force of 1,946.18 pounds for the unbalanced valves.

In connection with the 1889 experiments, opinions have been expressed that the use of the whole of the area of the back of the D valve, when estimating the coefficient of friction, was erroneous, on the ground that the only area affected by the pressure in the steam chest was an area equivalent to that of the steam ports. The argument is that if a flat plate of the same superficial area as the back of the valve were moved over another plate in the steam chest, there would be no friction; but if the lower plate had a hole, say two inches in diameter, bored through it, the force required to move the flat plate would only be that due to the pressure of the steam multiplied by the area of the hole, and as this opening became greater, so the force required to move the valve would also become greater.

In order to test this question, an experiment was made on another engine of the same class. A cast-iron plate was laid upon the ordinary valve face, and through it a two-inch hole was bored. An ordinary phosphor-bronze unbalanced D valve worked upon it, and the same dynamometer and recording arrangements were used for these experiments as for those

recorded in the first part of the paper. With this arrangement, Fig. 2, it was found that a force of 2,195.9 pounds was required to move the valve with a pressure of 160 pounds per square inch in the steam chest. The plate was then taken out, and the two-inch hole was enlarged to four inches, and five one-inch holes were drilled over each of the steam ports, Fig. 3. The dynamometer recorded exactly the same force of

TABLE OF RESULTS.

Forward or Back Gear.	Notch, 1 to 4	Push or Pull	Lubrication	Type of Valve	Boiler Pressure.	Steam-chest Pressure	Net Pressure on Valve	Total Force on Diaphragm, corrected.	Total Force Moving Valve.	Coefficient of Friction.
			Drops per min.		Lbs.	Lbs.	Lbs.	Lbs	Lbs.	
F.	1'	Pull.	4	"D" Valve Phosphor-Bronze	156	155.0	24,149.0	1,549.5	2,099.0	0.086
"	1	"	4	"	152	151.5	23,562.5	1,589.0	2,126.0	0.090
"	2	"	4	"	158	154.0	23,405.0	1,510.5	2,056.5	0.087
"	2	"	4	"	157	153.0	23,037.0	1,497.0	2,039.5	0.088
"	3	"	4	"	144	137.0	19,513.0	1,090.0	1,575.5	0.080
"	3	"	4	"	154	150.0	21,619.0	1,562.5	2,094.5	0.092
"	4	"	4	"	146	140.0	19,455.5	1,234.0	1,730.5	0.088
"	4	"	4	"	158	150.0	21,077.5	1,392.0	1,924.0	0.091
B.	1	"	4	"	158	155.5	23,894.5	1,497.0	2,048.5	0.085
"	1	"	4	"	149	154.5	23,929.0	1,497.0	2,045.0	0.085
"	2	"	4	"	152	150.0	21,924.0	1,444.5	1,976.5	0.090
"	2	"	4	"	155	147.5	22,052.0	1,313.0	1,836.0	0.083
"	3	"	4	"	150	145.5	20,824.0	1,300.0	1,816.0	0.087
"	3	"	4	"	156	151.5	21,801.5	1,300.0	1,837.0	0.084
"	4	"	4	"	155	152.0	20,819.5	1,103.0	1,642.0	0.078
"	4	"	4	"	147	140.0	19,248.5	1,129.0	1,625.5	0.084
F.	1	Push.	3	"	160	157.5	24,461.5	3,326.0	1,767.0	0.072
"	1	"	6	"	158	156.5	24,291.5	2,866.0	2,311.0	0.095
"	2	"	6	"	159	150.0	22,907.0	1,709.0	1,177.0	0.051
"	2	"	5	"	160	136.0	20,568.0	2,347.5	1,865.5	0.090
"	3	"	3	"	159	152.0	23,032.5	1,503.0	964.0	0.041
"	3	"	3	"	160	148.0	20,941.5	2,620.5	2,095.5	0.100
"	4	"	3	"	161	148.5	20,736.0	2,532.0	2,005.0	0.096
B.	1	"	3	"	160	147.0	22,502.5	2,973.5	2,452.0	0.108
"	1	"	3	"	158	152.0	23,732.0	1,915.0	1,376.0	0.057
"	2	"	3	"	158	142.0	21,184.5	2,826.5	2,322.5	0.109
"	2	"	3	"	164	160.0	23,605.5	3,326.0	2,758.5	0.112
"	3	"	3	"	158	147.0	21,292.5	2,914.5	2,393.0	0.112
"	3	"	3	"	160	150.0	21,677.0	2,944.0	2,412.0	0.111
"	4	"	3	"	158	140.0	19,995.0	2,468.5	1,972.0	0.098
"	4	"	3	"	160	145.0	21,165.5	2,503.0	1,988.5	0.093
"	1	Pull.	4	Balanced.	144	140.0	9,467.0	420.0	916.5	0.097
"	1	"	4	"	142	140.5	9,514.5	393.5	892.0	0.094
"	2	"	4	"	140	133.0	8,633.0	288.5	760.5	0.088
"	2	"	4	"	158	154.5	9,976.0	393.5	941.5	0.094
"	3	"	4	"	143	140.0	8,704.0	354.0	850.5	0.097
"	3	"	4	"	152	149.0	9,238.0	236.0	765.0	0.082

NOTE.—The regulator was full open in all the experiments.

2,195.9 pounds under these conditions. The intermediate plate was then removed and the valve was dropped upon the ordinary cylinder face, with the result that exactly the same force was found to be necessary to give movement to the valve. The author is of the opinion that this experiment disposes of the view that the area of the steam ports only should be taken into account. This is of interest, although the fact has been known for a long time in this country.

TAYLOR IRON.

Probably complete relief from anxiety with regard to the breaking of staybolts will never be had as long as fireboxes are made in the forms at present customary, but many believe that they reduce the amount of breakage of staybolts, and the danger from this source by the use of the best iron they can obtain. There are differences of opinion as to which of several irons is the best, and we are glad to note that there is a marked tendency toward discrimination in favor of improvement among railroad purchasers. With increased pressures not only do the repairs increase, but also the risks of being called into court to tell all about the quality of iron used for staybolts in sundry exploded boilers.

To make good staybolt iron the process must begin in the selection of the ore, and, while the entire process must receive the best of attention the results are probably affected most by the amount of "working" of the iron. "Taylor Yorkshire Iron" has long had an enviable reputation for excellence, and, what is more, uniformity of excellence. The makers use their own ore and keep such close check upon the manufacture, by aid of chemical and physical tests, as to render the records of some years ago a gauge of the present product. In proof of this we quote chemical analyses of May 27, 1895, March 1, 1898, and October 1, 1898, which were kindly supplied by Mr. F. E. Barnard of B. M. Jones & Co., of Boston, the agents of the manufacturers. These are as follows:

	May 27, 1895.	March 1, 1898.	October 1, 1898.
Carbon	Trace	None	Trace
Manganese	Trace	Trace	Trace
Silicon	.060	.140	.128
Sulphur	.021	Trace	Trace
Phosphorus	.100	.135	.137
Iron (by difference)	99.819	99.725	99.735

These tests were taken at random, and they fairly represent the reports received every week from the works. The physical properties appear to be not less uniform from the tests made on the United States Government testing machine at Watertown, in September, 1889, being representative now. Two samples from regular stock gave the following:

Elastic Limit.	Ultimate strength.	Elongation in 10 inches.	Contraction of area.
35,680	52,750	29.7%	53.3%
34,900	53,250	31.3%	54.1%

This staybolt iron is worked seven separate times, and that used for piston rods, crank pins and axles receives one additional heat for the "planish" working. The story of manufacture is told in the fact that nine tons of coal are used per ton of finished iron. The firm ships no billets, but finished material only, each piece of which is stamped, the axles being stamped at the center, where they are undisturbed in machining. No scrap is used, and Mr. Barnard tells us that from sales of about 200 piston rods per month less than five per year, as an average, are returned. Of a lot of 120 driving axles and 240 truck and tender axles furnished some time ago for 40 Mexican Central engines only one truck axle was discarded on account of defects when turned up.

The material has held the patronage of certain railroads for over 20 years, and now, with the inceasing requirements in staybolts it appears to be making more friends than ever.

COAL CARS.

American vs. English.

The following comparative figures of the weights of cars and trains used in American and English freight practice, the authority for which is Vice-President Joseph Price of the Grand Trunk, an English gentleman thoroughly conversant with the minutest details of railroading on both sides of the Atlantic, are interesting. With reference to the superiority of American freight cars, he said that he did not doubt that the concentration of the load in our trains is conducive to greater economy in operation, and spoke of a test with which he was identified four years ago, made for comparative purposes, by hauling a coal train on the New York, Ontario & Western from Middletown to Weehawken, and on the London & Northwestern from Rugby to Willesden, the distance being exactly 77 miles in each case.

The English train was made up of 57 coal wagons, having a total weight of 852 tons, and the American train had 24 gondola cars, the loaded weight of which was 919 tons. The paying load per cent. of the English train was 51.71, and of the American 61.11. The English train was 1,263 feet long and the American 857. The former train had 130 axles and the latter 109. These data show the large capacity of the American cars to be advantageous, but some facts had to be considered which would prove that cars of American capacity could not be used on English roads. On this phase of the subject it was explained that American cars are 12 tons in weight, with a capacity of 30 tons of coal, but the cars capable of use for such tonnage have to be very much wider than the English "wagons." All of the American cars are fixed on trucks, and the bodies of the cars partly overhang the permanent way, and to introduce them into the English system all the bridges and tunnels would have to be widened, which is too serious a matter to contemplate; besides which the English turntables would all be too short for the American cars. It is thought these facts dispose of the possibility of adopting the American system on English railways. [There is no doubt that the mammoth proportions of our freight equipment preclude its introduction on roads whose station platforms, as well as bridges and tunnels, have been designed for the service of smaller cars, but we do not exactly comprehend the status of the turntables in the economy of freight service. The need of it is not a pressing one on this side.—Editor.]

CAR CENTER PLATES—LUBRICATED.

In the article on "Freight Car Center Plates" in our February issue reference was made to the advantages of lubricating them in reducing curve resistances. We now present the practice of the Lake Erie & Western, by courtesy of Mr. P. Reilly, Superintendent of Equipment, who recounts his experience with the plates he devised and patented for his freight equipment and shown in Fig. 1, as follows: "I have had these plates in service now for several years, and by observation I find that the cars fitted with them show very little or no flange wear. There is also a very noticeable decrease in the end wear of brasses, which is a sure indication that the cars curve easily and consequently the hauling capacity of the engine is increased. I equipped one special car with these plates over a year ago and did not see the car again until after it had run over the year. On examination the plates were found to contain enough of the original oil to run another year, and the wheels showed no wear on the flanges nor did the journal bearings show any end wear worth mention.

"Center plates for cars of 60,000 pounds capacity should be about 12 inches in diameter on the bearing surface. The oil reservoir will hold one pint, which will ordinarily run a car two years without attention from the inspectors or repairers. It is not the intention that these plates should be oiled every now and then, the same as car journals, for we all know they would not be looked after by car inspectors, but the construction is such that the oil is retained in the reservoir in the upper plate and cannot leak out. It is used as needed, but does not get away. It is readily seen that a small quantity of oil will last a long time. The lubricating idea is a very simple one; it relieves the friction of the center bearings and does it in an inexpensive way, and does not require any attention except when the car is in the shop for general repairs, or about once in two years."

This would appear to be a good indorsement of the lubricating of parts that have heretofore had no attention whatever. The value of the device being judged by the measure of success achieved, there is certainly little room for argument against lubricating center plates. Fig. 2 shows the cast steel center plate recently put in service on the Northern Pacific and also referred to in the article noted above. This plate, as will be seen, has a loose liner interposed between the upper and lower sections, the upper one of which forms a reservoir to contain the lubricant and has a perforated bottom face to allow the oil free access to the liner and lower plate. There is no information available of the performance of this center plate, which was devised for the heavy capacity cars, but it is fair to assume that it will reduce curve resistance as far as rough center plates are responsible for it.

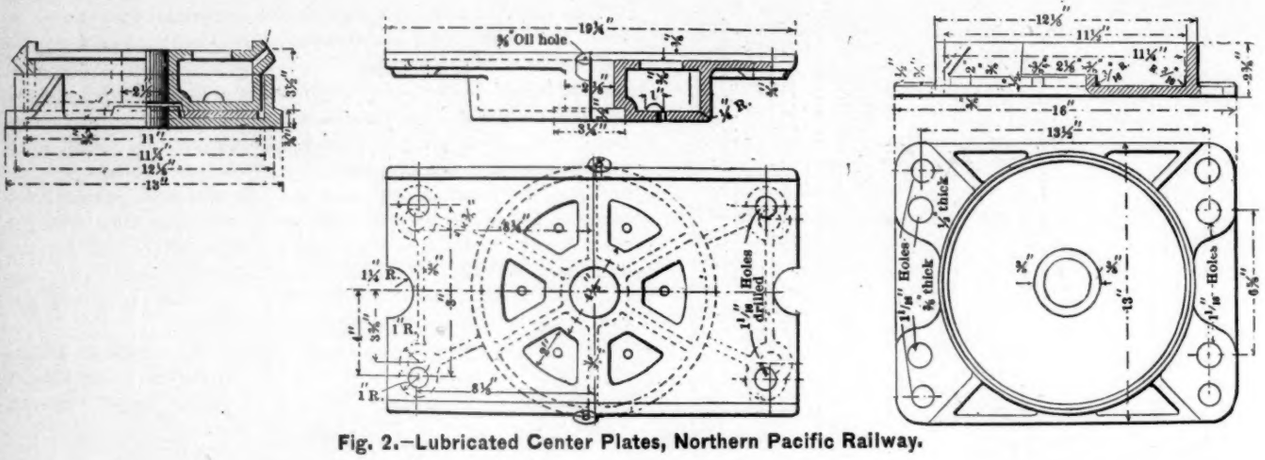


Fig. 2.—Lubricated Center Plates, Northern Pacific Railway.

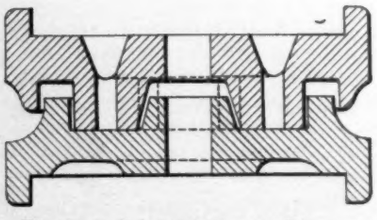


Fig. 1.—Lubricated Center Plates. Lake Erie & Western Railway.

Twelve new war vessels are recommended by the Naval Appropriation bill, reported to the House of Representatives February 8. Secretary Long, in his annual report, asked for 15 ships—three 13,000-ton battleships, three 12,500-ton armored cruisers, three 6,500-ton protected cruisers and six 2,500-ton cruisers. The bill, as reported, included all except the three 6,500-ton protected cruisers. The battleships will be seagoing, and will be sheathed and coppered; they will have the heaviest armor and armament of ships of their class, and the cost will be about $3,600,000, exclusive of armor and guns. The armored cruisers will have three screws each, which is probably due to the opinion of Engineer-in-Chief Melville. They will also be sheathed and coppered, and will cost about $4,000,000 each, not including armor and armament. The six small cruisers are to be built for high speed, without sacrificing features of cruising and long radius of action, and they will cost about $1,142,000 each.

PAY 10 CENTS TO SEE DR. DEPEW.

One of the privileges of being famous is to attract attention and it is sometimes profitable to recognize celebrated people. A good story is told of Chauncey M. Depew and President Callaway of the New York Central, who were "doing" the Omaha Exposition together, and happened to go into a "midway" booth.

It was a tame entertainment and there was only a meagre attendance when Mr. Depew and Mr. Callaway entered. Their stay would have been very brief except for the fact that they had scarcely taken their seats before there began a steady inpouring of people, which continued until the small auditorium was crowded.

Taking this extraordinary increase of spectators as an indication that something of an interesting nature was about to be disclosed the two New Yorkers concluded to sit it out. Half an hour's waiting failed to reward their patient expectancy, however, and Mr. Callaway suggested that they move on.

Just then ex-Secretary of Agriculture J. Sterling Morton pushed his way through the crowd, and extending his hand to Mr. Depew, exclaimed:

"Well, Doctor Depew, so you are really here! I thought that 'barker' was lying."

"What do you mean?" inquired Mr. Depew.

"Why, the 'barker' for this show is standing outside and inviting the crowd to 'step up lively' and pay ten cents for the privilege of seeing the 'great and only Chauncey M. Depew.'"

McCORD SPRING DAMPENER.

The McCord dampener for helical springs, as shown in our illustration, is a device which apparently deprives that type of spring of its objectionable snappy vibrations and makes it possible to use helical springs with comfort and safety in places heretofore impossible by reason of their too great sensitiveness, such as, for example, tenders and passenger cars. The importance of this cannot be overestimated, for the reason that the question of economy also comes in for consideration, and the relative cost of helical and elliptic springs is such that if by a mechanical device the former can be made to do the work of the latter, there will be no doubt as to which spring to use.

These features of the question were thought out about eight years ago by Mr. Geo. Gibbs, at that time Mechanical Engineer of the Chicago, Milwaukee & St. Paul, and now Consulting Engineer of the Baldwin-Westinghouse combination. Mr. Gibbs was the pioneer in the attempt to dampen the vibrations of coil springs and change their motion to the soft movement of the elliptic spring, by a device entirely distinct and apart from the springs themselves. The McCord dampener, however, is a part of the spring mounting, consisting of two sleeves that form the upper and lower seats for the spring.

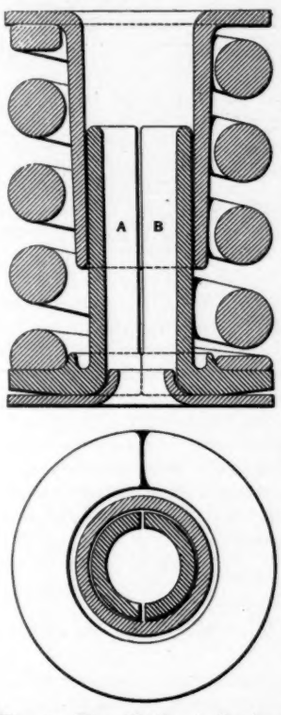


Fig. 1.—The McCord Spring Dampener.

The lower of these sleeves is split so as to form two pieces where it enters the upper sleeve, which is a continuous piece. The flanged base of the lower, or split, sleeve is of spherical form, and the spring rests on the outer edge of the flanges. Here is the mechanical principle on which depends the success of the device as a dampener. When the load comes on the spring, the halves of the lower sleeve become a pair of bent levers, owing to the spherical contour of the base, and the upper ends are thus forced out against the continuous sleeve with an intensity proportional to the lever arms and the load, giving a frictional resistance between the sleeves that, under shocks, causes a slow movement and brings the spring to rest with but one vibration. This will be readily understood by reference to the illustration, Fig. 1.

A comparison of the vibrations of helical and elliptic springs is nicely shown graphically in Figs. 2, 3 and 4, by means of

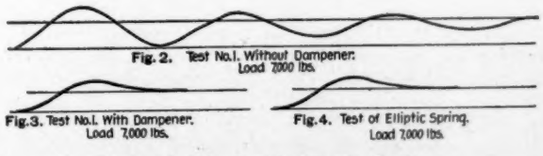


Fig. 2. Test No.I. Without Dampener. Load 7,000 lbs.
Fig.3. Test No.I. With Dampener. Load 7,000 lbs.
Fig.4. Test of Elliptic Spring. Load 7,000 lbs.

Tests of Spiral and Elliptic Springs.

diagrams obtained by the attachment of a revolving drum to a testing machine. The horizontal right lines were made on the diagram by causing the drum to travel under the pencil; the upper of these lines being made while the beam was in its normal position with no load, and the lower ones by depressing the beams until the spring came to a solid bearing, and then allowing the beam to vibrate with freedom. The resultant of these movements of the drum and beam is the sinuous line shown in each figure. Fig. 2 represents a coil spring without a dampener, and therefore very active. Fig. 3 shows the effect of the dampener on the same spring, and Fig. 4 shows the normal action of a 36-inch, 5-leaf elliptic spring. These show plainly the effect of, and while highly gratified by these lines as bearing out their theory that the action of the helical spring is made equal in all respects, as shown in the diagram, to that of an elliptic spring, the owners of the device have found facts in practice to sustain all claims made for it. It has been in use on a tender for a long period, and the results are exactly what were expected. McCord & Company, of New York and Chicago, are the manufacturers and are prepared to furnish the device for service.

RAILWAY STATISTICS.

The statistician of the Interstate Commerce Commission has prepared summaries from the tenth statistical report for the year ending June 30, 1897, from which we make some extracts of interest. Of railways we find that of the total of 184,428.47 miles, there were 128 roads in the hands of receivers. These roads operated 18,861.68 miles, the mileage owned by them being 14,894.57 miles. These figures, as compared with those for 1896, show a net decrease of 11,613.71 miles operated, and 8,622.89 miles owned by roads in charge of receivers. During the year ending June 30, 1897, 51 roads were removed from the control of receivers, and 28 roads were placed under their management. An inspection of the roads operated under receiverships on June 30, 1897, shows that 22 operated a mileage in excess of 300 miles; 20 between 100 and 300 miles, and 70 a mileage less than 100 miles.

Equipment figures give the total number of locomotives in service on June 30, 1897, as 35,986, an increase in number over the prevous year of 36. Of the total number of locomotives reported, 10,017 were classed as passenger locomotives, 20,398 as freight locomotives, and 5,012 as switching locomotives. The number of locomotives without classification was 469. The total number of cars of all classes reported in service on the date named was 1,297,480. The corresponding number for the previous year was 169 greater. Of the total cars reported, 33,626, or 623 more than for 1896, were assigned to passenger service; 1,221,730 were assigned to freight service, indicating a decrease of 157 during the year; and 42,124 were assigned to the special service of the railway companies. This record does not include cars owned by private companies and individuals that are used by railways in transportation service.

Taking the United States as a whole, it appears that 48,861 passengers were carried, and 1,223,614 passenger miles accomplished per passenger locomotive, and correspondingly there were 36,362 tons carried and 4,664,135 ton-miles accomplished per freight locomotive. All of these items show a decrease as compared with those of the preceding year. The number of passenger cars per 1,000,000 passengers carried during the year under consideration was 69, and the number of freight cars per 1,000,000 tons of freight carried was 1,647. It should be understood, however, that this average does not include such cars, mainly in the freight service, as are owned by private parties, for the use of which the railways paid during the year approximately $11,000,000. Including in the term "equipment" both locomotives and cars, it is found that the total equipment of railways on June 30, 1897, was 1,333,466. These figures are 133 less than on June 30, 1896. Of this total number 525,286 were fitted with train brakes, the increase being 76,432, and 678,725 were fitted with automatic couplers, the increase in this case being 133,142. These increases are somewhat smaller than the corresponding increases for 1896.

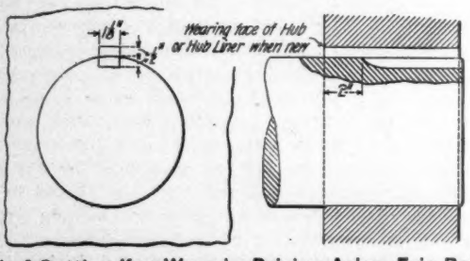
Further equipment details on June 30, 1897, show that the number of passenger locomotives fitted with train brakes was 9,899, or 83 more than the preceding year. The number of freight locomotives so fitted was 18,796, or 875 more than the preceding year. The number of switching locomotives fitted with train brakes was 3,666. The number of passenger locomotives fitted with automatic couplers was 4,687, the increase with respect to 1896 being 184. The number of freight locomotives fitted with automatic couplers was 4,192, the increase being 819. The number of switching locomotives fitted with such couplers was 741, or 147 more than for 1896. The number of passenger cars fitted with train brakes on June 30, 1897, was

33,078, and the number fitted with automatic couplers was 32,661, the increase being 665 and 815 respectively. The number of cars in freight service fitted with train brakes was 453,688, or 74,630 more than in preceding year. The number fitted with automatic couplers was 629,399, indicating an increase of 129,166. Of the total cars in service 492,559 on June 30, 1897, were fitted with train brakes, and 668,937 were fitted with automatic couplers, the increase for the year in the former case being 75,237, and in the latter 131,989.

The number of men employed by the railways of the United States on June 30, 1897, was 823,476. These figures, assigned on the mileage basis, show 449 men per 100 miles of line. The corresponding figures for the preceding year were slightly larger. The employees of railways are divided into 18 classes. The number of station agents was 30,049; other station men, 74,569; enginemen, 35,667; firemen, 36,735; conductors, 25,332; other train men, 63,763; switchmen, flagmen and watchmen, 43,768, and telegraph operators and dispatchers, 21,452. A distribution of employees corresponding to the four principal divisions of the classifications of operating expenses shows that general administration required the service of 31,871 employees, or 17 per 100 miles of line; maintenance of way and structures, 244,873, or 134 per 100 miles of line; maintenance of equipment, 160,667, or 88 per 100 miles of line, and conducting transportation, 378,361, or 206 per 100 miles of line. This statement disregards a small number of unclassified employees amounting to 7,704. For the year ending June 30, 1897, it appears that the aggregate amount of wages and salaries paid was $465,601,581. This amount represents 61.87 per cent. of the total operating expenses of railways, or $2,540 per mile of line. The total compensation for 1896 was $3,222,950 greater.

DRIVING AXLE KEY-WAYS.—ERIE RAILROAD.

To the end of securing immunity from fracture of driving axles at the hub, more attention is given to construction detail at that point than formerly, in which not only the wheel fit, but the key-way are important factors. The practice of the Erie in this regard is shown herewith by courtesy of Mr. A. E. Mitchell, Superintendent of Motive Power. The wheel fit is of the same diameter as the journal. The method of key-way construction is new, and is no doubt a great improvement, for the reason that there is no starting point for fracture, as that portion of the key-way cut in the axle ends two inches from the inner face of the wheel, and has the most advantageous form for pre-



Method of Cutting Key Ways in Driving Axles—Erie Railroad.

serving the strength of the axle by its curvature of large radius. This, of course, is as beneficial to the wheel hub as to the axle in preventing the starting of an incipient crack. In our issue of May, 1898, the method of key fitting on the Chicago, Burlington & Quincy was shown, in which the inner end of the key-way is curved to a radius of 2 11-16 inches, but it extends 1 inch past the shoulder of the wheel fit into the journal. These are good examples of needed improvement in key-way cutting.

A novelty in train robbery is reported from France. A passenger was riding from Bordeaux to Paris alone in a compartment, and was beginning to doze, when he perceived a strange odor, which awoke him just as a man tried to open the door. On pulling the alarm bell cord the man disappeared, and it was found that a tube had been passed from the next compartment through a hole in the partition and chloroform was passed through the tube. We cannot forbear remarking that foreigners often pay well for their exclusiveness in traveling.

COMMUNICATIONS.

SHORT SMOKE BOXES FOR LOCOMOTIVES.

Editor American Engineer:

I have been expectantly waiting for the advocates of long smoke boxes to defend their position in reply to the descriptive article on short smoke boxes in your December paper of last year, but apparently they are now all in the business of changing to short fronts because of their silence. I have always held the opinion that the smaller the smoke box the better the influence of the draft upon the fire and that this is because the exhaust from the nozzle causes a dilation of the gases in the smoke box due to the vacuum produced by the blast. Now it is this vacuum that causes the draft through the tubes from the firebox and these gases rush into the smokebox to fill the spaces that were occupied by the gases driven out by the blast. The degree of dilation of the gases in the smoke box will be greater as the smoke box volume is made smaller and in consequence of this the smaller smoke boxes will produce better draft on the fire, the action of the exhaust being the same. To put this in a brief and clear way I should say that for any given condition of exhaust action the smaller the cavity in the smoke box the stronger the vacuum will be in it and the more energetic the effect upon the fire. This means that larger nozzles may be used with short front ends and this is very desirable. I would like to know if I am wrong in regard to this idea of the vacuum. S. M. P.

Feb. 14, 1899.

[We think this view is correct and would like to hear from any one who has data to confirm the opinion. We have no such data, but we know of 19 by 24 inch moguls with the Bell front end that are running with 4⅝-inch nozzles while similar engines with extension fronts are running in the same service with 4⅛-inch nozzles. The division master mechanic in charge of the engines informs us that the short fronts are saving fuel, but no comparative tests have thus far been made. It seems unnecessary to argue the question of fuel saving in this case, because if the nozzles are opened a half inch and the engines do the same work as before, there must be a saving of fuel.—Editor.]

CAR CONSTRUCTION.

Editor "American Engineer:"

In your January issue I note some editorial comments on a paper read by Mr. F. M. Whyte at the recent meeting of the Western Railway Club, and desire to say that a sense of gratification was the dominant one before finishing the article for the reason that the views therein expressed are sound from a mechanical standpoint. The important lesson conveyed in the paper is that the rule of guess work in car design is nearing its end, and this is the more convincing because there are no propositions made that will not bear investigation. The assumption that a bolster should be made stiff enough to carry the load clear of the side bearings has often been made, but as far as my knowledge of the subject goes, I have never before been told how to design it so as to keep the bending moments where they could do the least harm, and therefore leave the bolster in the best condition to resist the stresses brought to bear on it.

The analyses of the stresses at work to produce deflection of the bolster are interesting, and while fairly well understood by the advanced car man, should be considered as a valuable part of the general contribution to the light thrown on the subject. This applies also to the location of the truss rods and their influence on the strength of the bolster, yet there will doubtless be cars constructed in the future with the outer truss rods as near to the outside sill as they can be placed, notwithstanding the evil effect of such location is plainly pointed out, so slow is the process of evolution. The recommendations of the paper in this regard are worthy of more than passing note, since they make it plain that the nearer the center the car the rods are placed, the shorter becomes the lever arm of the load on these rods, and the less the bending moment at center of bolster.

The suggestions as to needle beam bearings on the sills, and their office in transmitting a part of the load that properly belongs to the center sills, to the truss rods and through them

to a point remote from the center of bolster, hint at the possibility of getting into complications from a quarter not hitherto touched upon. There is ample excuse for giving some thought to these suggestions from the fact that accurate information on the points noted is scarce; as a matter of fact, they are so new as to require some little study before their full import will be plain to all what they are intended for. The paper referred to is one of the best, for the reason that it puts one in touch with the weightier mechanical engineering aspects of car construction, and therefore instructs. Permit me to say that it is the kind of car literature the readers of the "American Engineer" like to have. RONALD HAYDEN.

Feb. 16, 1899.

SHOULD COMPOUNDS SHOW ADVANTAGES OVER SIMPLE ENGINES AT LOW PRESSURES.

Editor American Engineer:

I like your editorial on "The Present Status of the Compound Locomotive," on page 405 of your issue of December, 1898, but one thing must be kept in mind, the compound must be designed to show economy with the same pressures as are used with simple engines. Even if we start with a boiler designed for 200 lbs. in a few years the pressure will need to be reduced, and this limit will be shorter with 200 than with 180 lbs. All compounds should be so designed that they may have the steam pressure reduced to 140 lbs. and yet show a relative gain. C.

Chicago, Jan. 30, 1899.

[We are surprised that it is necessary to direct attention to the fact that a boiler pressure of 140 lbs. is not economical for any locomotive. When a boiler that is built for 200 lbs. pressure is unsafe to run with about 160 lbs., it is unsafe to run at any pressure, and should be discarded. By designing locomotives so that different engines can use the same sized boilers, one that is originally used on a compound at 200 lbs. may afterward serve at a somewhat reduced pressure on a simple engine in less exacting service, but there is a limit to this plan. In reply to our correspondent's last sentence we ask whether marine engineers insist that multiple expansion engines should show superior efficiency to single cylinder engines working with steam at 30 lbs. pressure. This appears to be a parallel case.—Editor.]

BALDWIN COMPOUNDS.—LEHIGH VALLEY RAILROAD.

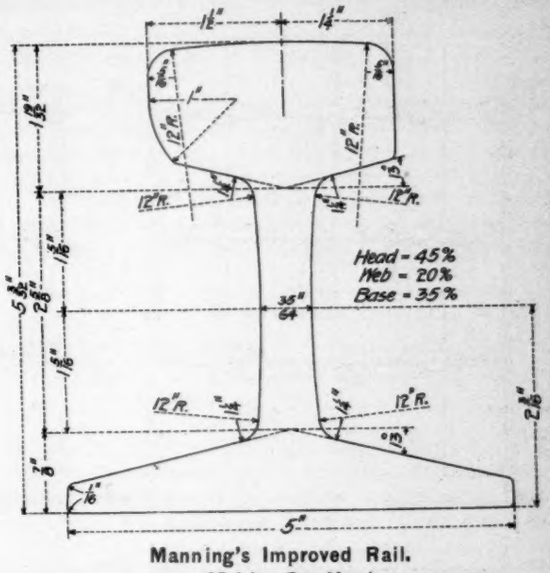
The Lehigh Valley has ordered nine heavy mountain locomotives similar to the one illustrated on page 395 of our December issue. This is taken to indicate satisfaction with the first one which, while guaranteed to haul 1,000 tons from Coxton to Fairview, has actually hauled 1,082 tons over this section without apparently reaching the limit of power. This distance is about 27 miles, and the grade is over 1 per cent. This engine is one of the heaviest ever built, and it had 4,105 square feet of heating surface. It has a Wootten firebox, the details of which and the boiler were illustrated in our January issue, page 11. In addition to the enormous boiler, this engine is interesting because it is a compound. It was remarked in describing the engine that its performance would be watched with interest, and this will not be diminished by the new order, which may be accepted as an expression of confidence.

CHEAPER SLEEPERS ON THE BALTIMORE & OHIO.

An innovation in sleeping car practice was put into effect Feb. 13, on the Baltimore & Ohio, by running two classes of sleeping cars—one of the usual sumptuous character, and one of an "ordinary" kind. In the former, the luxuriously inclined traveler may continue to pay high prices with his wonted prodigality, and in the more common car the rates are reduced one-half. The B. & O. is the first road to cut on the exorbitant price of a night's rest, and the way taken to accomplish the end is quite worthy of more than passing thought. We have not sampled the quality of the accommodations furnished, but if they are equal to the ordinary service on some roads, sensible travelers will not hesitate to forego the splendor of the higher priced berth for the plainer one.

THE MANNING RAIL.

The Chief Engineer of the Baltimore & Ohio, Mr. W. T. Manning, takes the ground that initial wear on a rail head is the only wear to be considered in main line track, or, in other words, that rails turned after the limit of wear is reached on one side are unsafe. In order to increase the life of a rail a greater amount of material is placed in the head on the



Manning's Improved Rail.
85 Lbs. Per Yard.

wearing side, and this can be done, it is said, so as to reduce the cost 37 per cent. a ton per year. This improved rail is to have its merits demonstrated on the Baltimore & Ohio, and on the Pittsburgh & Western. The Carnegie Company has received orders for 1,000 tons for the first named road and 500 tons for the latter, the design being shown in the accompanying engraving.

JERSEY CITY STATION OF THE PENNSYLVANIA RAILROAD.

On the night of March 21, 1898, the Pennsylvania station at Jersey City caught fire, which destroyed the waiting room, dining room and restaurant, and seriously threatened the whole structure, including the offices and train shed. The rebuilding preparations have been carried forward on a scale that will make this terminal one of the best. The train shed will be the longest in this country—777 feet, with twelve tracks—exceeding in width that of any of the Chicago stations, and will be 15 feet longer than the Grand Central Station in this city, but will have but half the width. The new portion built to replace the burned part will be framed of steel and iron, while the exterior will be of bronzed metal.

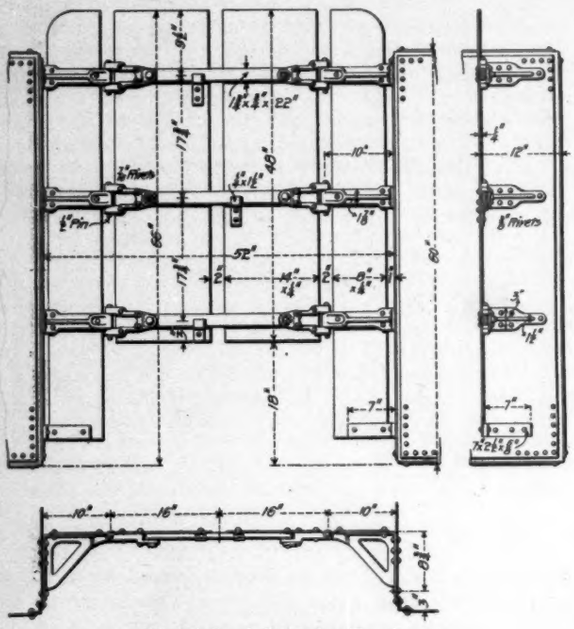
The new waiting room and restaurant is now in a well advanced state, having been pushed rather more than the other parts of the work. A part of the waiting room is now open to the public; the interior finish is in panels of plaster and the columns are cast after artistic designs, in harmony with the general pleasing effect of the decorations which are of white staff. The size of the room now opened for use is only one-half of its finished dimensions, which are to be 60 by 80 feet.

The restaurant is to be 80 by 80 feet, and a part of it will be used as a waiting room until the latter is fully completed. The lobby will be 550 feet long and 60 feet wide, and will be finished in staff in the same tasteful way as the waiting room. The increased size of the train shed will enable the company to dispatch about 25 per cent. more trains than formerly and in a more satisfactory manner than ever before. To provide this length of 777 feet in the train shed, it will be necessary to move the entire eastern end of the old shed 125 feet toward the river, which will give that amount of room to be utilized in the total length. This, it will be seen, involves a nice bit of engineering. The whole station will, it is estimated, cover when completed, about six acres.

METAL COAL GATE FOR TENDERS.

New York, Chicago & St. Louis R. R.

The coal gate for locomotive tenders which is illustrated here was designed with a view of using a permanent construction to save the continual expense and annoyance of keeping wooden gates in repair. These metal gates are supported by neat and strong hinges and brackets, which may be made of malleable



Metal Coal Gate for Tenders.
N. Y., C. & St. L. Ry.

iron, and they are held against the thrust of a load of coal by three substantial cross bars of ¾ by 1¾ inch iron fitting into suitable sockets. We are indebted for the drawing to Mr. John Mackenzie, Superintendent Motive Power of the New York, Chicago & St. Louis R. R., who is now using this plan with very satisfactory results.

STORAGE BATTERY LOCOMOTIVE IN FRANCE—PARIS, LYONS & MEDITERRANEAN RAILWAY.

Our readers are familiar with the Heilmann locomotive, and will be interested to know of a new electric locomotive, recently described in "La Nature." This one makes use of storage batteries, and was built under the direction of M. Baudry, Chief Engineer of the Paris, Lyons & Mediterranean, for use on that line.

The locomotive was built in the latter part of 1897, and has been used experimentally on the line between Paris and Melun. It has three axles, two of which are drivers, and has about one-half the power of the ordinary express locomotives on that road; but it would suffice to double the number of driving axles to give it the normal power of the ordinary locomotive. This locomotive is followed by a tender carrying storage batteries, the hauling of which absorbs a considerable part of its power on account of their great weight, and this would be unnecessary if the third rail or overhead trolley were employed. The driving and carrying wheels are 1.1 meters in diameter. The front compartment of the locomotive is depressed so as not to interfere with the view from the engineer's cab. The cab contains an air compressor operated by a small electric motor of five horse power which furnishes compressed air for the Westinghouse brakes, for the whistle and for the regulating apparatus. The three other compartments, two situated at the right and one at the left, are one meter high and contain each nine cells of storage battery. These are connected in series and serve to excite the fields of the compressor motor and furnish the current necessary for the air compressors and for the electric lighting of the cab, etc. The cells may also be employed to run the locomotive itself at low speed. The middle compartment contains a large water rheostat controlling the large motors on the driving axles.

Current is furnished by two main storage batteries of 96 cells each carried on the tender. The normal strength of current in regular operation is 700 amperes, being equivalent to 300 horse power at a speed of 500 revolutions, equivalent to 103 kilometers per hour. Under these conditions, the difference of potential at the brushes is 360 volts. The capacity of the eighteen cells carried on the locomotive proper is 1,500 ampere hours. The plates of a cell represent a weight of 140 kilograms. The total weight of the locomotive is 44,500 kilograms, 12,500 of which rest on the first leading wheels, and 16,000 kilograms on each of the two main drivers. The total weight of the tender is 45,800 kilograms. The storage batteries number 192 and are able to deliver 1,000 ampere hours at the rate of 500 amperes. The armatures are built on the Brown system, the conductors being enclosed in the iron of the armature. Their diameter is 0.690 and their length 0.540 m.

Its first trip was made on Nov. 26, 1897, between Paris and Ville-neuve-St. Georges, with only 48 storage cells in the tender. Since then it has made a number of trips between Paris and Brunoy with 48 cells; then between Paris and Melun first with 100 cells, and finally with its complete equipment of 192 cells. The maximum load hauled between Paris and Melun was 147 tons, including the tender on the locomotive at the speed of 45 kilometres per hour. In lowering the load hauled to 100 tons the speed of 62 miles per hour was reached, corresponding to an effective power of 611 horse power.

GASOLINE ENGINES FOR RAILROAD USE.

The Boston & Maine has reduced the cost of pumping water at Barrie Plains, Mass., to ¾ cent per 1,000 gallons by the use of a gasoline engine, the best record of steam for the same conditions of lift having been 7 cents for the same unit.

The New York Central has installed a gasoline engine for hoisting ice, and the Illinois Central is using a gasoline engine combined in one bed with an air compressor at the bridge over the Salt River at West Point, Kentucky, we understand, for pneumatic riveting.

A combined air compressor and gasoline engine is now being fitted up in a box car at the South Union station in Boston for use in operating a sand blast and a paint spraying machine for use along the line of the New York, New Haven & Hartford.

CHINESE ORDER FOR 81 LOCOMOTIVES.

A dispatch says the Baldwin Locomotive Works, Philadelphia, have just closed a contract for the building of 81 locomoitves, one of the largest single orders ever received by that company. The locomotives are for use on new railroads now under construction in China. The contract was under consideration about a year ago, but the breaking out of the war with Spain caused doubt regarding the safe delivery of the engines, and the matter was dropped for the time. Over $800,000 is involved in the work, and the Baldwin Company will rapidly push construction.

M. C. B. AND M. M. CONVENTIONS.

The Master Car Builders' Association will hold its 33d annual convention at Old Point Comfort, Va., at the Hotel Chamberlain, beginning June 14, 1899. The Master Mechanics' Association will open its 32d annual convention at the same place on Monday, June 19. The Chamberlain and the Hygea hotels have joined in making rates for attendants at the conventions.

A very large gas engine plant which "Engineering" says is probably the largest in existence, is to be installed at the Lots' road pumping station of the London County Council. The plant will include 8 double cylinder horizontal Crossley gas engines, four of them rated at 260 I. H. P. each, and the other four at 210 I. H. P. Four 5 H. P. gas engines combined with air compressors complete the engine plant. The engines will use coal gas.

"Wait a While," a railroad station in New South Wales, has just won a fight to retain its name, which the railroad company wished to change.—"Scientific American."

DISHONEST SHIPPERS.

A curious case of swindling on the part of a shipper has recently been unearthed by the Interstate Commerce Commission, which exemplifies the ease with which competition may be overcome when leverage of this kind is applied. The particulars are as follows:

Complaint had been informally made to the Commission that some concerns engaged in selling turpentine in the South were making a lower price on their product than other dealers in the same line. An inquiry developed the fact that a large company engaged in the turpentine and petroleum trade had built a large number of tank cars adapted for the transportation of oils, and had certified to the railways that the full capacity of the tank cars was 6,000 gallons, and this was the capacity entered in the tank-car gage book issued by the Central Traffic Association.

The rate schedules filed by the Commission under Section 6 of the statute provide that oils carried in tank cars shall be charged for transportation according to the full capacity of the tanks, irrespective of the quantity of oil actually shipped. Investigation brought out the fact that the true capacity of these tank cars was 6,500 gallons, and not 6,000 gallons, as the owner and shipper had certified to the railroads. Turpentine being rated at seven pounds per gallon, the shipper had the advantage of 3,500 pounds free haulage for each car. The shipments were from Savannah, Ga., and Pensacola, Fla., to Chicago, Cleveland, Detroit and St. Louis, and, since these cars were returned South, laden with petroleum, competition was made to languish until the scheme was nipped in the bud by the Commission. It would be interesting to know to just what extent the culprits were amenable to the law, and, if accountable, what has been done about it.

TRAIN LIGHTING ABROAD.

In certain portions of Europe train lighting is just now attracting the attention of those governments which regulate such matters paternally. Russia, for example, has formulated a ukase that passenger trains must be lighted from electric accumulators. First class carriages must have a lamp of 100 candle power, second class carriages 80 candle power, and third class carriages 50 candle power. Besides these provisions, the lamps must be supplemented in compartments by candles, for use in case the electricity fails to work. France is making regulations for train lighting in tunnels. An old rule was operative only where a tunnel was 1,300 ft. long or over. The new Minister of Public Works thinks the time taken to pass through a tunnel should be the governing factor, and not the distance, and that functionary has handed down an opinion that a new rule should be promulgated by which a passenger could not be forced to remain in darkness more than 30 seconds at one time. Public opinion and competition regulates the light question in this country, but, of course, such little things are powerless over there. It would seem as though that ought to be a good field for the application of car lighting apparatus.

PERSONALS.

Mr. S. F. McLeod has been appointed Purchasing Agent of the Duluth, Missabe & Northern, with office at Duluth.

Mr. G. M. Beach has resigned as Assistant General Manager of the Pittsburg & Lake Erie, on account of poor health.

Mr. Joseph Geimer has been appointed Master Mechanic of the Maricopa, Phoenix & Salt River Valley RR. at Phoenix, Arizona.

Mr. J. S. Thurman has resigned as Mechanical Engineer of the Missouri Pacific, to give his attention to his pneumatic inventions.

Mr. Samuel Sloan was elected for the 35th time as President of the Delaware, Lackawanna & Western, at the recent annual meeting.

Mr. P. D. Plank has been appointed Master Mechanic of the Louisville, Henderson & St. Louis Railway, vice Mr. D. Vanalstine, resigned.

Mr. Charles Parsons has resigned the presidency of the Ogdensburg & Lake Champlain, and is to be succeeded by Mr. Percival W. Clement.

Mr. S. Phipp, formerly Road Foreman on the Canadian Pacific, has received the appointment of Assistant Master Mechanic, with headquarters at Winnipeg.

Mr. G. H. Goodell has been appointed Mechanical Engineer of the Northern Pacific, leaving a like position on the Erie, where he is succeeded by Mr. Howard Williams.

Mr. J. S. Chambers, formerly Superintendent of Motive Power of the West Virginia Central & Pittsburg, is appointed Master Mechanic of the Buffalo Division of the Lehigh Valley, at Buffalo.

Mr. John Lundie has received the appointment of Consulting Engineer for the Boston Elevated Railway Company. Mr. Lundie was formerly connected with the Chicago suburban lines of the Illinois Central.

Mr. C. Skinner has been appointed Master Mechanic of the Toledo, St. Louis & Kansas City at Frankfort, Ind., succeeding Mr. F. J. Pease, resigned. Mr. Skinner was formerly Master Mechanic of the Alabama Great Southern.

Mr. John J. Ellis, for several years at the head of the machinery department of the Chicago, St. Paul, Minneapolis & Omaha, with the title of Master Mechanic, has been made Superintendent of Motive Power and Machinery.

Mr. M. S. Curley, Master Mechanic of the Illinois Central at Water Valley, Miss., has been transferred to Paducah, Ky., in charge of mechanical matters on the Louisville Division and the Fulton district of the Memphis Division. He succeeds Mr. W. Hassman, resigned.

Mr. Arthur Leonard, for a number of years private secretary to Mr. H. Walter Webb while Vice-President of the New York Central, and later identified with the motive power department of the New York Central, has been appointed assistant to President Spoor of the Chicago Terminal.

Mr. W. H. Welch, Supervisor of the Elmira & Canandaigua Division of the Pennsylvania, has refused an offer of the position of Inspector of Railroads, under the New York Board of Railroad Commissioners at a salary of $3,000, although this is much more than his present salary on the Pennsylvania.

Mr. W. P. Coburn, formerly Assistant Master Mechanic of the Chicago, Indianapolis & Louisville, has been promoted to the position of Master Mechanic, made vacant by the resignation of Mr. Henry Watkeys. Mr. Charles Coller, formerly Master Car Builder of this road, has received the appointment of Assistant Master Mechanic in charge of car work.

Professor J. B. Johnson, of Washington University, St. Louis, has resigned, to become Dean of the College of Mechanics and Engineering of the University of Wisconsin. He has earned a world-wide reputation by his original investigations, particularly in the subject of the strength of timbers and by his writings on the subject of the strength of materials.

Mr. W. H. Truesdale, First Vice-President and General Manager of the Chicago, Rock Island & Pacific, has resigned, to succeed Mr. Sloan in the Presidency of the Delaware, Lackawanna & Western, March 1st, with office in New York. Mr. Truesdale is one of the best and most favorably known railroad men in the West, and his place in the management of the Rock Island will be very difficult to fill.

W. S. Calhoun, who represented the American Steel Foundry Company as General Eastern Agent, died suddenly of pneumonia at Macon, Ga., Tuesday, Feb. 14, and was buried in Chicago. Mr. Calhoun at different times represented several very prominent railroad supply firms and he obtained a large part of his extensive acquaintance while connected with the Chicago Tire & Spring Company. He lost his health several years ago and spent some time in traveling, after which he took a position with the Brussels Tapestry Company. He was very successful, particularly in connection with the business of the American Steel Foundry Company, and he will be missed, especially by railroad and supply men, among whom he had a great many friends.

Mr. J. D. Layng, who has been Vice-President and General Manager of the West Shore Railroad since 1884, has tendered his resignation, which will be effective August 1, and he will retire with well-earned laurels. Mr. Layng has been in railroad service since 1849, beginning as a rodman on the Ohio & Pennsylvania. He was Superintendent of the Eastern Division of the Pittsburg, Fort Wayne and Chicago Railroad from 1865 to 1871, and General Manager of the Pennsylvania lines from 1874 to 1881. His connection with the West Shore dates from the time of its royal battle for existence against the New York Central, where he has remained to manage its operation since. August 1 will complete fifty years of active railroad life. After April 1 the West Shore management will be consolidated with that of the New York Central.

Mr. William E. Baker, who has just left the Metropolitan Elevated of Chicago, to become General Superintendent and Chief Electricial Engineer of the Manhattan Railway of New York, has been closely identified with the development of electric railroads, and especially with this power as employed upon elevated roads. He designed and installed the Intramural electric railroad at the World's Fair in Chicago, and afterward designed and installed the electric equipment of the Metropolitan and became General Superintendent of that road at its opening. He is 42 years of age, and received his education in Lafayette College. After spending a number of years in the engineering departments of several of the most important of the railroads in the Northwest, he entered the employ of the Thompson-Houston Co., for whom he installed the electric equipment of the West End Street Railway of Boston. Upon its completion he took charge of the Intramural in Chicago. Mr. Baker's appointment in New York is believed to be an indication of the policy of the Manhattan to immediately take up the change from steam to electric traction.

Mr. Godfrey W. Rhodes, whose change from the head of the mechanical department of the C., B. & Q. to accept the position of Assistant General Superintendent of the Burlington & Missouri River we noted last month, has earned the distinction of being one of the leading motive power officers of the time. It will not seem at all natural to think of him as in any other position than that which he has filled so ably and so long, and the American Engineer desires to protest if this change means that he will take a less active part in mechanical matters in which his opinions have such weight. The Master Mechanics' and the Master Car Builders' Associations never had more faithful and conscientious support, assistance, wise counsel and intelligent advice than that given always modestly, always fearlessly, disinterestedly and sincerely by Mr. Rhodes, and always for the good of the associations and for the railroads of this country. Being a successful motive power superintendent and possessing, as he does, excellent organizing ability, he will bring unusual experience to bear on transportation questions and intimate knowledge of motive power matters, notwithstanding their importance, is not too common among transportation officers.

Mr. F. A. Delano's appointment to succeed Mr. G. W. Rhodes as Superintendent of Motive Power of the Chicago, Burlington & Quincy, was briefly noted last month. Mr. Delano is but 35 years of age, and has been connected with the Burlington for about 14 years. He entered the shops of the mechanical department at Aurora, and after serving apprenticeship, took charge of the Bureau of Rail Inspection and Tests, where he did very important work, which is reflected at the present time in the good condition of the tracks of the road. He was afterward made Assistant to the Second Vice-President, and in July, 1890, he was appointed Superintendent of Freight Terminals in Chicago, the position which he has just left to take charge of the motive power department. Mr. Delano is a graduate of Harvard University and combines education and a varied, yet concentrated, experience with good business and executive ability. He has the advantage over many motive power men in having a thorough knowledge of road and transportation, as well as motive power subjects. It is becoming unusual for a superintendent of motive power to be succeeded by a man on his own road which is an additional reason for congratulating the Burlington and Mr. Delano.

ELECTRIC RAILWAYS IN GERMANY.

Consul W. K. Anderson writes that up to the end of the year 1891 the number of cities in the German Empire enjoying the advantages of electric street railways was three; up to the end of 1892, five; 1893, eleven; 1894, nineteen; 1895, thirty-two; 1896, forty-four; 1897, sixty-one; and on the 1st of September, 1898, no less than sixty-eight. In thirty-five other cities or districts, railways are in the course of construction or finally determined upon. The entire length of electric lines in operation in Germany on Sept. 1, 1898, was 888 miles, and the total trackage was 1,205 miles. The number of motor cars was 3,190, and the number of trailers 2,128. The length of the new lines in course of construction or about to be begun at that date was 677 miles, and their total trackage 830 miles.

Most of the large industrial cities in Westphalia and the Rhine Province are connected by a network of electric roads, which serve not only for passengers, but for freight traffic.

The electric street railway of Hanover was built under the supervision and direction of an American from Philadelphia, and was opened for business on May 1, 1892. It was one of the first electric lines inaugurated in Germany, and is now one of the best systems in existence. The cars are modeled after our American ones, and the tracks are of heavy steel, laid on a substantial foundation of concrete. The fare for a course of, say, 2 miles within the city limits is 10 pfennigs, or less than 2½ cents of our money. Universal transfers are granted. The speed is about 8 miles per hour, and the cars run smoothly and with but little noise. Within the mile circuit and upon some of the principal streets extending to the city limits, the cars are run on the accumulator system; but when the outskirts are reached, the accumulators are released from service and the cars are run by overhead trolley. The lines extend, on almost every road, miles into the surrounding country. The trackage of the Hanover Electric Railway now amounts to over 105 miles. The equipment consists of 41 overhead trolley cars, 161 accumulator and trolley cars combined, 167 trailers, 20 locomotives, 4 sprinklers, and 24 freight cars. There are six power stations, four of which furnish, in addition to power for the cars, electric light for streets and roads. The motor cars are from 17 to 34 horse power, and the locomotives 50 horse power.

EQUIPMENT AND MANUFACTURING NOTES.

The Jackson & Sharp Company of Wilmington, Del., have an order for 16 coaches and 4 combination cars for the Philadelphia & Reading.

The Pennsylvania Steel Co. made the lowest bid on the New Orleans dry dock, their proposal being $810,000, which is $40,000 below the maximum price decided upon by the government.

The Union Pacific has ordered 40 10-wheel and 8 12-wheel simple locomotives from the Brooks Locomotive Works. The 10-wheelers will weigh 165,000 pounds, and will have 20 by 28-inch cylinders, and the 12-wheelers will weigh about 200,000 pounds in working order, and the cylinders will be 21 by 30 inches.

The Baldwin Locomotive Works are now setting up a new steam motor car for the Pennsylvania. It will have a speed of 40 miles an hour, and carry sufficient coal to run 50 miles. It is designed to meet the competition of electric roads.

The Pressed Steel Car Co., which is a consolidation of the Schoen and Fox interests, has received an order for 1,000 steel cars from the Union Pacific. The cars will be of the hopper and gondola type, and of 80,000 pounds capacity.

Mr. Henry L. Leach, North Cambridge, Mass., sold 318 sets of the Leach locomotive sander during the month of January, which number is 63 larger than the best previous record. The list includes orders from all of the prominent locomotive builders and many of the most important railroads.

An unprecedented rush of business is being enjoyed by the Brooks Locomotive Works, and requires the employment of 1,640 men in the different departments, which is 300 in excess of the number engaged at this time last year. The works are being run night and day. The important additions that are being made to the shops will probably be finished early in March.

The American Impulse Wheel Company of New York reports some very large electric transmission work in hand and most valuable results from all their installations. The company is increasing an already large home and export trade.

The Egyptian Government is reported as contemplating a steel car equipment for service on the Soudan Railroad, which is to ultimately connect Alexandria with Cape Colony, but Khartoum is to be the present terminus. From Cape Colony a road is now under construction toward the Zambesi country; this road is to embrace Rhodesia; it will cross the Zambesi River, and from there proceed to Khartoum. The Schoen Pressed Steel Company has, we understand, had an opportunity to furnish the steel equipment required for this road in the Dark Continent.

A recent issue of "Indian Engineering" referring to a prospective purchase of locomotives, says: "There is a probability of a new departure being taken by the Government of India in the matter of providing railway locomotives. An order for several engines is likely to be placed with American firms, as the makers in England are so busy that they cannot undertake to complete Indian orders within a reasonable time. The Central Bengal Railway Company has already tried American locomotives, which have given every satisfaction."

The recent order of the Baltimore & Ohio Railroad for five thousand steel coal cars, to be built by the Pressed Steel Company brings the total purchases of the receivers of the Baltimore & Ohio Railroad up to 30,394 since March 1, 1896. The locomotive purchases during that time have been 216, of which about 20 are still to be delivered. The company has also purchased five postal cars, ten express cars, ten combination cars and six dining cars.

Mr. E. P. Mooney, for the past seven years connected with the Lehigh Valley Railroad as Traveling Engineer and Master Mechanic, and prior to that time for twenty-four years with the Lake Shore & Michigan Southern Railroad as Locomotive and Traveling Engineer, has severed his railroad connections to take charge of the Buffalo office of the Chicago Pneumatic Tool Company. Mr. Mooney has a wide acquaintance among railroad men, and with his well-known energy, will assuredly make a success in his new position, and increase the sales of the Chicago Pneumatic Tool Company in his territory.

A brace for locomotive frames has been patented by Mr. D. A. Wightman, Superintendent of the Pittsburg Locomotive Works. This brace is one adjunct of an engine that gives a most satisfactory return for the investment. As a frame stiffener it must perform its functions perfectly, because it fills the space between frames, and extends from the cylinder saddle to the bumper beam. It is of cast iron, ribbed for lightness, and is securely bolted at the front and two sides. It is hardly necessary to say that the object of the brace is to relieve the saddle castings of the enormous strains brought upon them when the frames are unsupported at the front. Extended use of the device has been found to prevent breakage of saddles and to bear out the claims Mr. Wightman makes for his improvement.

The Carnegie Steel Co. has verified the story to the effect that it will abandon the proposition to manufacture steel cars, inasmuch as they have contracted with the Pressed Steel Co. to supply that firm with all the shapes and plates needed. The contract with the Pressed Steel Co. will involve almost $5,000,000 per year. The Pressed Steel Co. will have a capacity of 75 cars per day. These cars contain about 12 tons of steel, This will make a tonnage of 900 per day. With 312 working days, about 280,800 tons of steel will be consumed annually, which at a price of $18 per ton would make $5,050,000 per year. The Pressed Steel Co. now has contracts booked amounting to about $8,000,000 which, together with the contracts turned over to them by the Carnegie Steel Co. will amount to an aggregate of $10,000,000. The Pressed Steel Co. has abandoned the plan of building a steel mill.

The rehabilitation of the Baltimore and Ohio South Western Railway will begin as soon as the frost is out of the ground in the Spring. Just before the line went into the hands of Receivers Harmon and Robinson a large quantity of material was purchased. This will be immediately delivered and used to the best advantage. Forty thousand tons of 85 pound steel rail have been purchased, and enough will be on hand on March 1 to enable the receivers to begin laying it at five different points on the line. Each mile of track will be carefully reballasted and placed in first class condition. It will take 101,000 pairs of continuous rail joints for the forty thousand tons of rail. The two thousand standard box cars and five hundred steel coal cars recently ordered will be delivered in March. Additional motive power, in the shape of forty compound freight engines, weighing 156,000 pounds, and five ten wheel compound passenger engines, weighing 135,000 pounds, is now being built by the Baldwin Locomotive Works. It is expected that by the time the property is reorganized and becomes the southwestern division of the Baltimore and Ohio Railroad it will be in a physical condition fully equal to the Baltimore and Ohio Railroad.

The remarkable progress made by tools operated with compressed air is well shown by the immense calls made for the product of the Chicago Pneumatic Tool Company. Complete plants have now been supplied to the following countries: England, Belgium, France, Germany, Holland, Italy, Sweden, Russia, Egypt, Australia, India, Japan and South America, and the universal use of these tools in this country is to be added to the above. At a trial of the Boyer tools at Glasgow recently before a number of shipbuilders the results were of such a favorable character that all the ship yards on the Clyde are now said to be equipped with them. The economical use of air in the rotary devices constitutes one of their strongest points, and is chiefly responsible for their rapid introduction whenever given a trial, and this when coupled with the fact that the machines are constructed on mechanical principles by mechanics makes good their claim for superiority in workmanship as well as results. These tools have shown such a very marked gain in quantity of work turned out over the older methods that they displace that their use is now an actual necessity in order to meet competition in manufacturing, and explains the wide use of them in industrial works. The workmanship in these tools surprises foreigners and freedom from vibration is one of the strongest claims made for them. After taking one of the Boyer tools apart, a representative of "Engineering"—see issue of that journal, Jan. 6, 1899 — said: "The examination thus made showed this work to be, all things considered, one of the best examples of mechanical engineering we have ever met with." The Clyde shipbuilders and English boiler makers and locomotive builders are surprised at the power and efficiency of these tools, especially the hammers, riveters, drills and chain hoists.

BOOKS AND PAMPHLETS.

The Locomotive Up to Date. By Chas. McShane; 711 pages. Illustrated. Published by Griffin & Winters, New York Life Building, Chicago, Ill. Price, $2.50.

This book is by the author of "1,000 Pointers for Machinists and Engineers," and in many respects the style of the former work has been followed in the present one. Both books are written with a view of meeting the requirements of engineers

and machinists, and in the one before us a large amount of information concerning locomotives and their details is given. The treatment of slide valves, valve setting and the compound locomotive are most complete, while a great deal of attention is given to breakdowns, running repairs, combustion and machine shop methods. All of the important parts of the locomotive are considered and a great many devices that have been reported to be giving satisfaction are described and illustrated, nearly all of these, however, have appeared in the technical periodicals, but this does not take from the value of the book because of the convenience in having them collected and indexed. For example, here are more than twenty locomotive valves, each illustrated and described. We are glad to have this record, even of some valves that are not in general use and this feature of the book will be valuable to those who contemplate taking out patents for improvements in locomotives. They may save themselves trouble by consulting this book. The work is written in a plain style, well adapted to those who will consult it. The compound locomotives of all the prominent American types are fully illustrated and descriptions of each have been prepared by the builders themselves. Chapters on special subjects are from authorities on those subjects, as, for instance, the one on water impurities by Mr. F. W. Hornish, the inventor of the Hornish boiler cleaner, and on air brakes by Mr. Clinton B. Conger. The engravings and press work are fair.

Electric Railroad List of the World. Published Quarterly by the "Railroad Gazette," 32 Park Place, New York, January, 1899. Volume 1, No. 1.

According to the editor's announcement, this publication is designed to furnish quarterly a list of the companies operating the electric, cable and horse railroads throughout the world, together with the names and addresses of the more important officers. In short, it does the same for street railways that is done by the well-known "Pocket List of Railroad Officials" for the steam roads, and for convenience the size and general arrangement of the steam railroad list have been followed. The information has been obtained from official sources, and is believed to be reliable, as far as this is possible in the initial publication on such a complicated subject. The foreign list is naturally not complete, but omissions in the first issue are expected under the circumstances. This list will be invaluable to those who have occasion to use the names and addresses of these officials, and, as a matter of convenience, information is given covering the mileage, character of motive power and equipment of each road. As the list will be used most by those who have to do with supplies, the officials in charge of the purchasing department are plainly indicated for each road. In addition to the railway list, this publication gives the bibliography of the subject of data concerning street railways, an alphabetical list of advertisements, a list of representatives of supply companies, one of the associations of officers, an alphabetical finding list of officers of all the roads included in the book, proposed standard operating rules and proposed standard classification of accounts. The letterpress is good and the book is attractive and convenient.

Association of Railway Superintendents of Bridges and Buildings, Eighth Annual Convention, October, 1898.

This pamphlet has been received from Mr. S. F. Patterson, Secretary of the Association, and copies may be obtained by addressing him at Concord, N. H. It contains the usual records of the proceedings of the association, and also a very valuable series of tables of the strengths and deflections of wooden beams and columns, showing the safe loads and deflections which are based upon recommendations of a committee of the association appointed in 1895 to report on the subject. The tables are the work of Mr. Edgar Kidwell and Mr. C. F. Moore.

American Society of Mechanical Engineers. List of Officers, Members and Rules. Jan. 1, 1899.

This society issues two semi-annual catalogues or lists, one standard size (6 by 9 inches) and the other vest pocket size (2¾ by 5 inches). We have received a copy of the former, which is an improvement upon all society catalogues that we have seen, in that the entire membership is given in a single list, with the grade of each member indicated. It has also a territorial list, but in other respects does not differ from previous catalogues of the society. The new vest pocket list will be specially valuable to members traveling, because it will include a geographical arrangement of the names.

Report of the Surgeon-General, U. S. Navy, Chief of Bureau of Medicine and Surgery to the Secretary of the Navy, 1898. Government Printing Office.

Catalogue and Price Lists of Brown & Sharpe Manufacturing Co., Providence, R. I., 1899.

The catalogues of this celebrated firm are always sought after not only by those who desire information concerning the product described, but by those who find the information in machinery lines valuable in their business. The volume before us contains 45 pages, and besides presenting the well-known products of the works that are too well known to require comment, includes a number of new features or additions, enumeratedas follows: Angular cutters with side ground concave, automatic gear cutting machines, automatic threading machines, corner rounding cutters double angle cutters, face milling cutters with inserted teeth and with threaded holes, improved stocking cutters, index wheels and worms, internal gear cutting attachments for automatic gear cutting machines, interlocking side milling cutters, metric involute gear cutters, milling cutters, milling cutters with nicked teeth, plain grinding machines Nos. 11 and 16, plain milling machines, No. 3 with screw feed; shell end mills, straight and spiral and arbors for same, spiral end mills, universal milling machine No. 1½. The catalogue will be sent upon application to any address without charge, and it is a good one to have on the desk.

Acme Machinery Company's Catalogue.—One of the neatest, most comprehensive and useful catalogues coming to us this year is that of the Acme Machinery Company, Cleveland, Ohio. The first feature to commend it is the standard size, 6x9 inches; the next to attract attention is the wood cuts and half tone engravings, illustrating their products, and last and most important of all, the excellent press work. This catalogue will repay consultation by anybody interested in bolt cutters and nut tappers, or bolt heading and forging machines, for the reason that it gives concisely the information the inquirer wants. The lead screw attachment for accurate or coarse pitch screws is illustrated and its purposes explained, and some good advice on making and recutting dies is formulated with cuts to illustrate the text. There are also some useful tables specially valuable to the bolt maker, such as the amount of stock required to make square and hexagon bolt heads; the Acme standard upsets showing length and diameter of upset for stock from ½ to 3 inches diameter; diameters, areas, weight per lineal inch and per lineal foot of round iron; number of boiler rivets to 100 pounds, etc. This latter information is prepared in pocket form, which will be sent free to any one asking for it. This company no longer publishes a list of users of their machines, as a proper presentation of their output requires all the available space in their catalogue, which now comprises 116 pages. The guarantee made in a few lines is thought to be of greater significance than a reference to the long list of patrons.

The "Book of the Royal Blue" for February, published by the Baltimore & Ohio Railroad, contains a very instructive article on "The Regular Army of the United States," by Major H. O. Heistand, Assistant Adjutant General. Major Heistand gives facts and figures concerning the military department since its organization, during the War of the Revolution. Some of his statistics are very interesting. During the Revolution the number of individuals actually in military service did not exceed 250,000; in the war of 1812 there were 471,622, of which 62,674 were regulars; in the war with Mexico there were 116,321, of which 42,545 were regulars; in the War of the Rebellion there were 2,259,168 United States troops, of whom 178,975 were colored and 67,000 regulars, the total being 2,326,168; in the war with Spain there were 219,035 volunteers (10,189 being colored) and 55,682 regulars, a total of 274,717. Major Heistand also gives the number killed, wounded and lost, and the deaths from disease in each war, including the Indian wars, and other important facts.

The Ingersoll-Sergeant Drill Company have issued a new catalogue numbered 41, showing their product in every conceivable application to land and submarine work. It is illustrated by means of clean cut half-tone engravings, which are reproduced from actual practice, in which these machines have played so prominent a part. The automatic feed and variable stroke features are fully explained for the benefit of those interested in the mechanics of the machines. The paper and presswork of the 104 pages is of the best. A comprehensive and well arranged index, and its standard size of 6 x 9 inches will make this work a valuable addition to any catalogue file. The address of the Ingersoll-Sergeant Co. is 26 Cortlandt street, New York.

We have just received a handsome colored poster from J. A. Fay & Company, the well known manufacturers of wood working machinery, of Cincinnati, Ohio. This poster is printed in red and green on fine white paper, it is about 25 x 38 inches in size, and shows in perspective over 100 of their latest designed wood working tools, the product of a special corps of experts in this line, whose only instructions are to make these tools the best of their kind. They will send one of these posters free to any one interested in wood working machinery.